

Technician Issues Missouri

NCAUPG Workshop
St. Louis, MO
January 11, 2006



Percent-Within-Limits (PWL)

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

Statistical Methods

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

Comparing to Specification

- Calculate Average and Standard Deviation

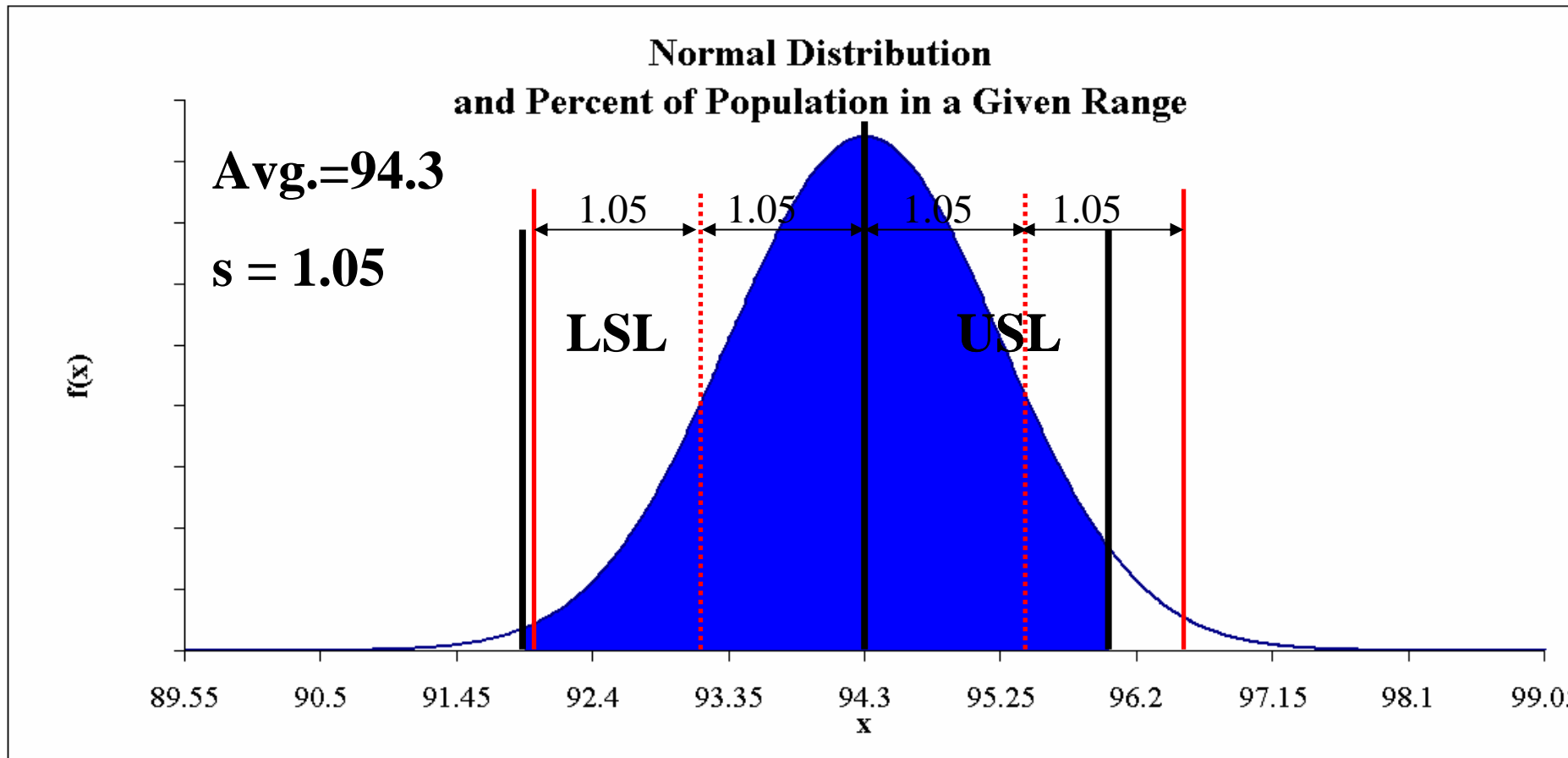
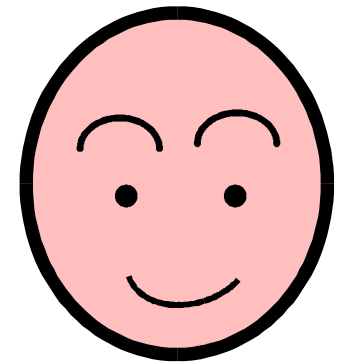
$$\bar{x}_a = (\sum x_i)/n \quad s = (\sum (x_i - \bar{x}_a)^2 / (n - 1))^{1/2}$$

- Calculate Quality Indices

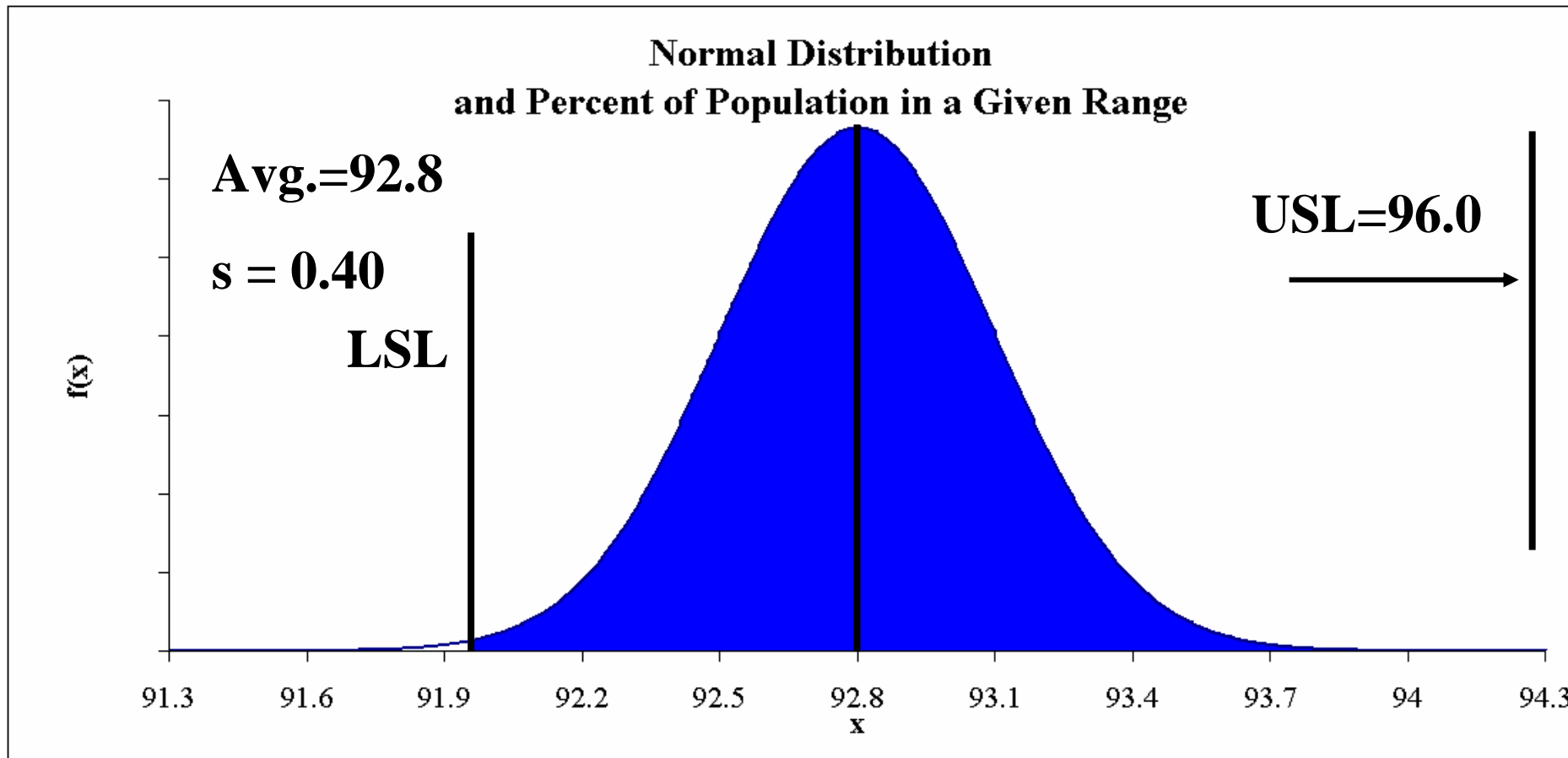
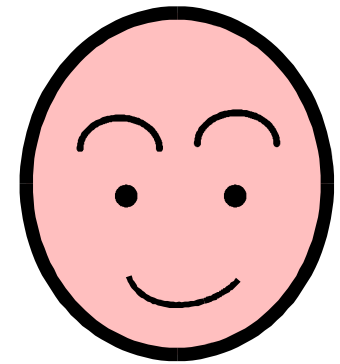
$$Q_u = (USL - \bar{x}_a)/s \quad Q_l = (\bar{x}_a - LSL)/s$$

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

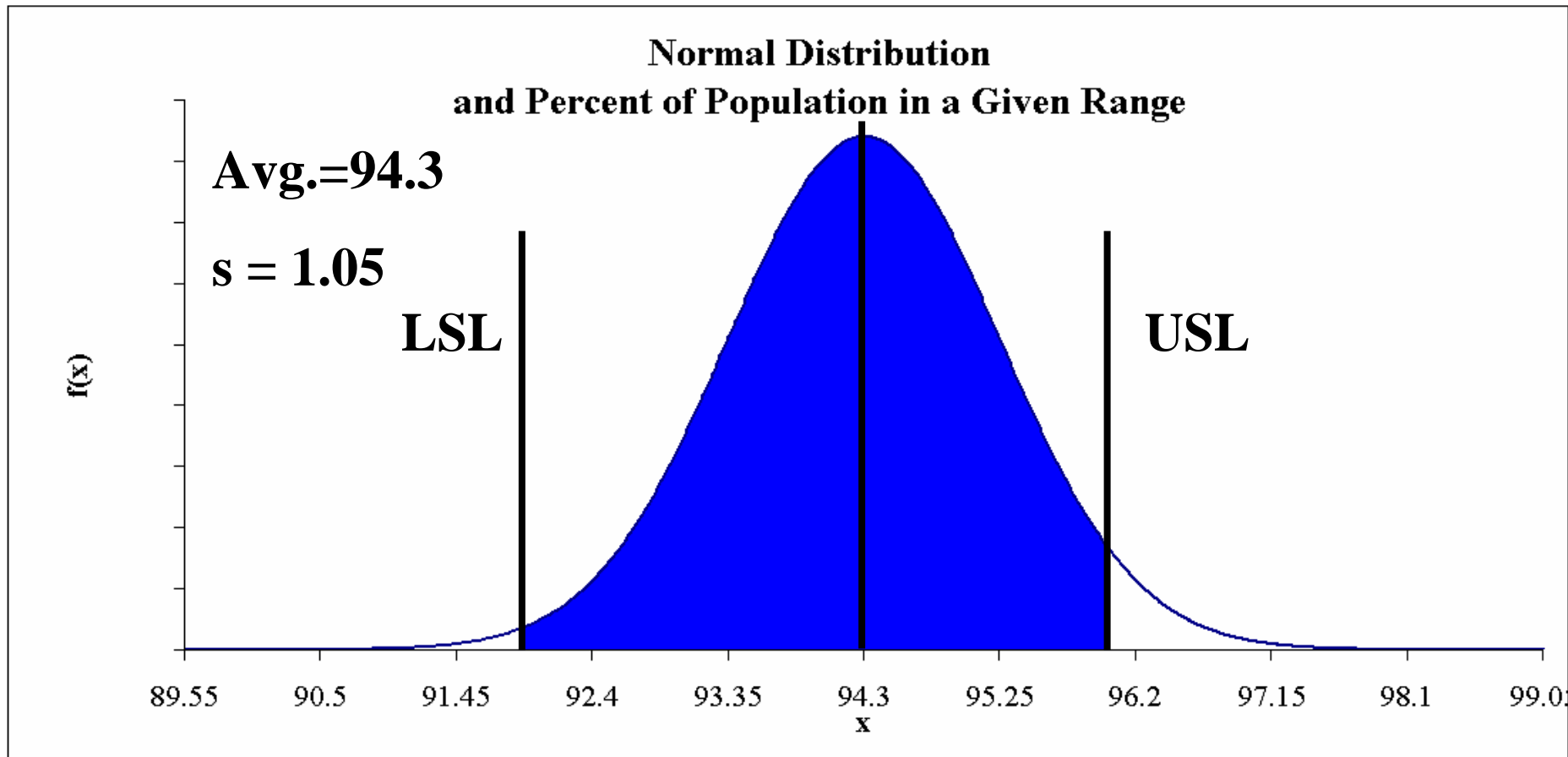
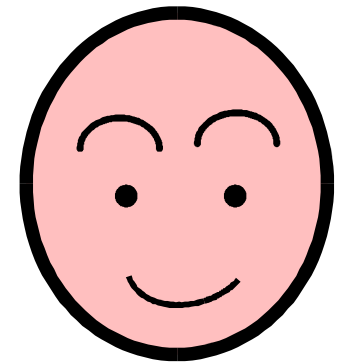
Density PWL 95.69



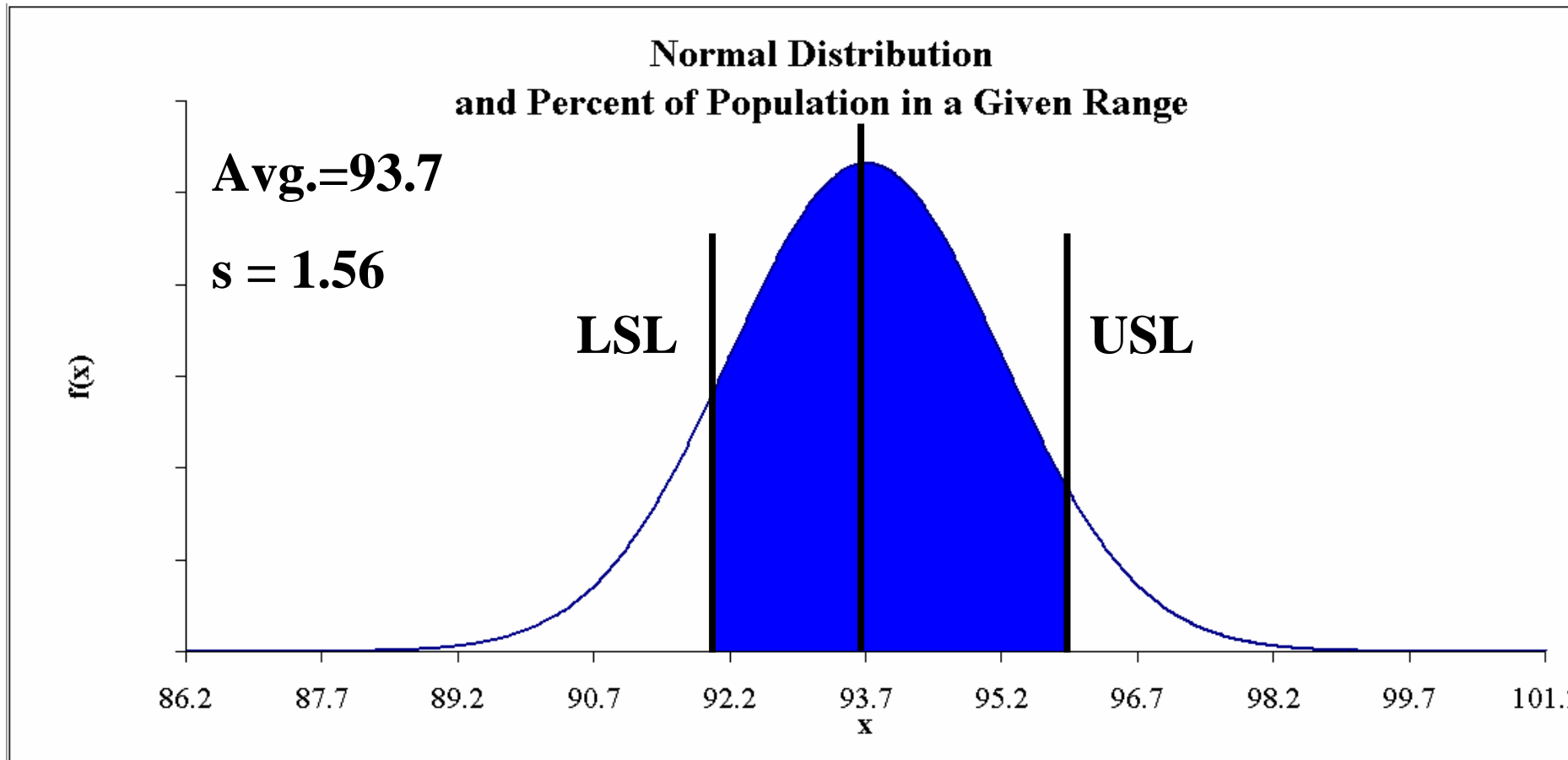
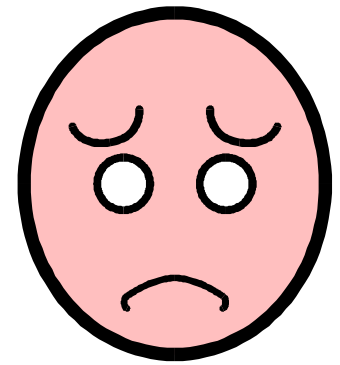
Density PWL 99.84



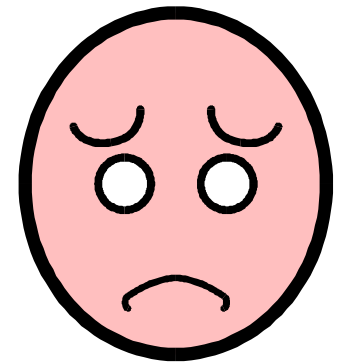
Density PWL 95.69



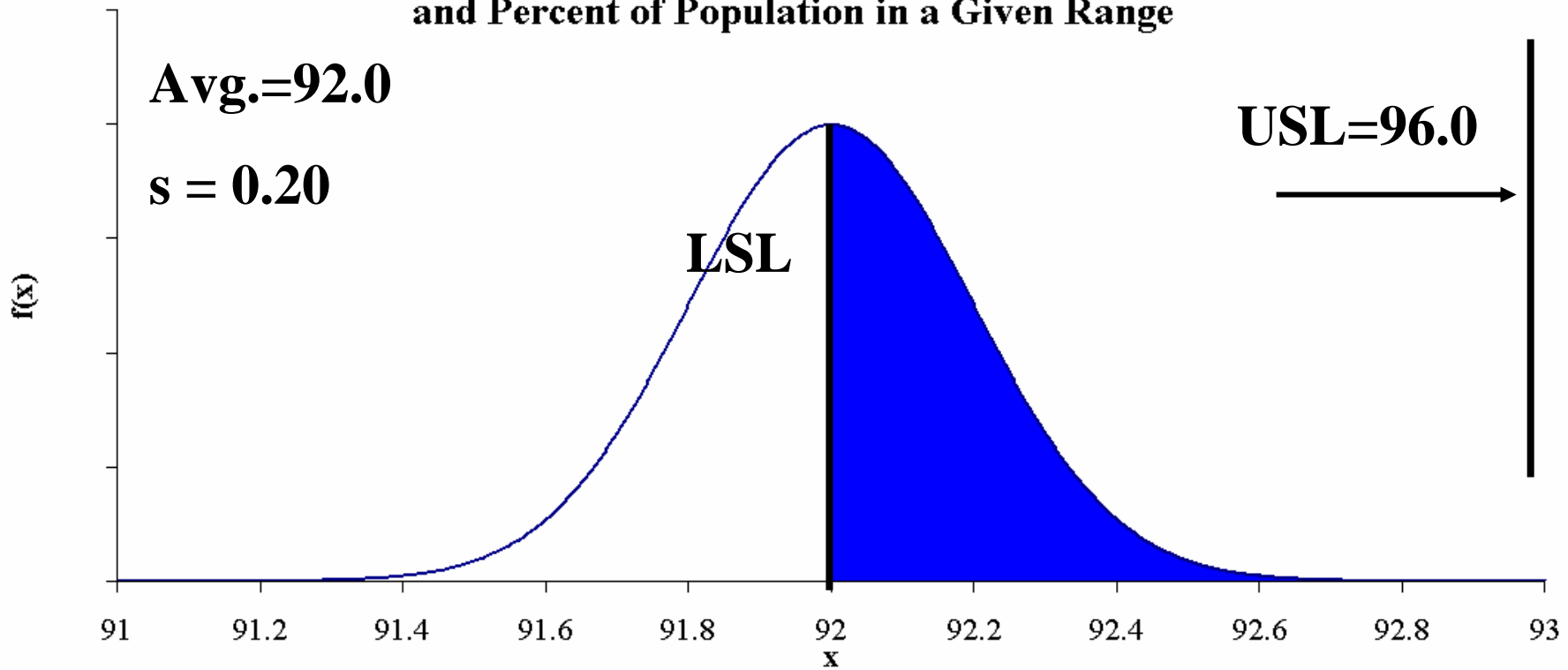
Density PWL 80.00



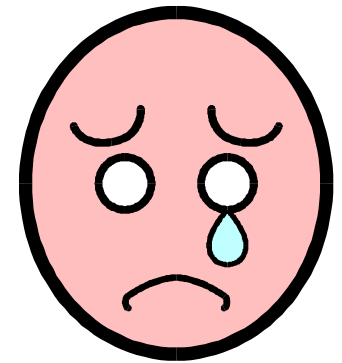
Density PWL 50.00



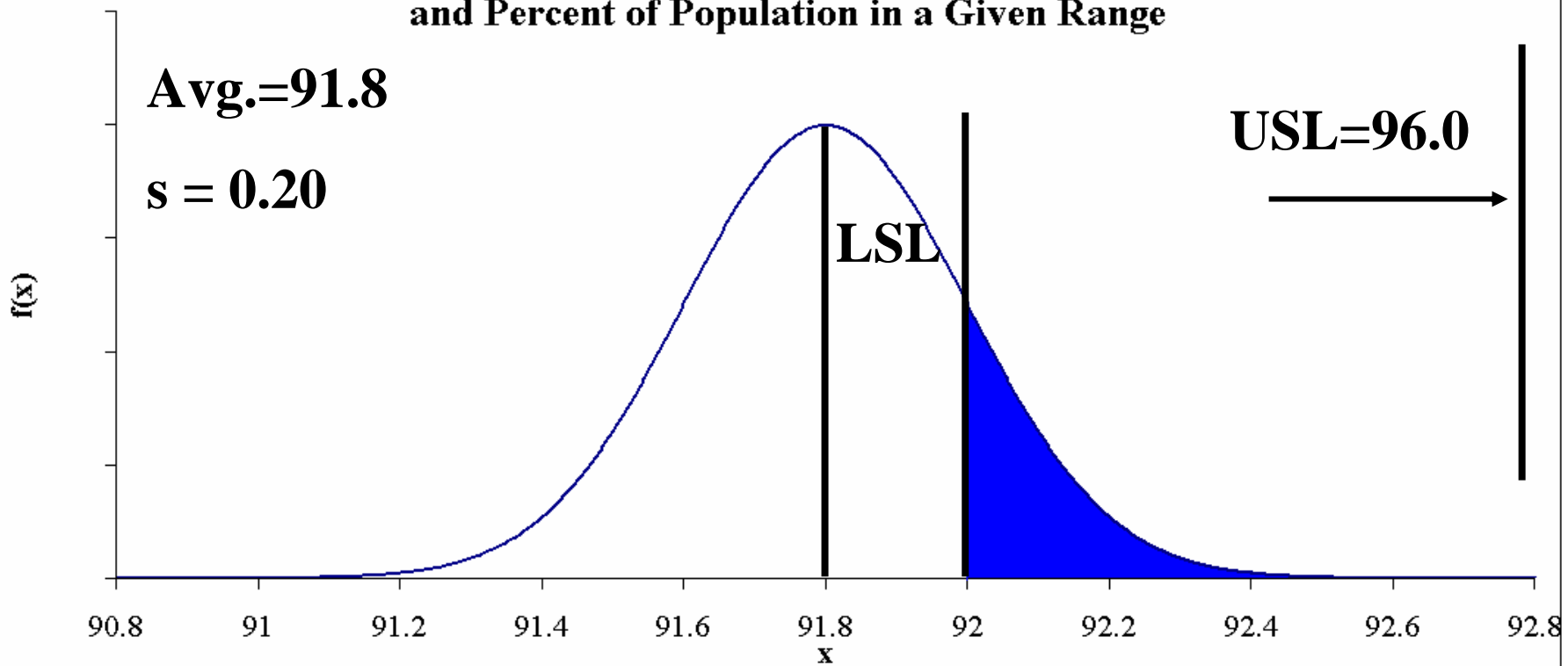
Normal Distribution
and Percent of Population in a Given Range



Density PWL 18.79

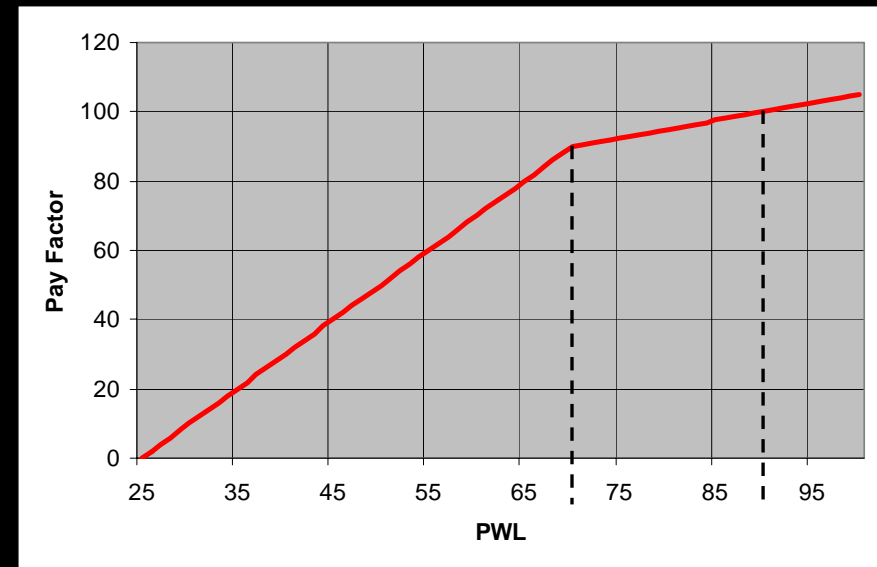


**Normal Distribution
and Percent of Population in a Given Range**



Pay Factors

- Pay Factor for Each Item
When PWL_{+} is greater than or equal to 70:
 $PF = 0.5 PWL_{+} + 55$
When PWL_{+} is less than 70:
 $PF = 2 PWL_{+} - 50$
- As Quality Decreases;
Penalty Increases
More Quickly

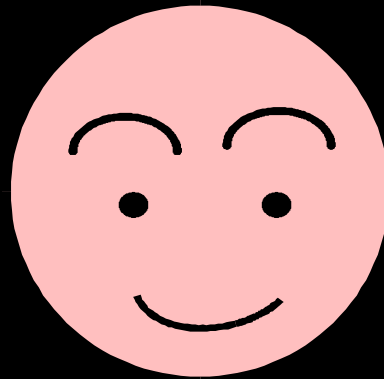


Remember: Quality Counts!

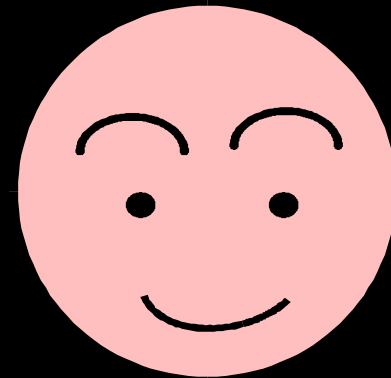
Good
Material

Bad
Material

Accept



Reject



| | Density | Asph. Cont. | VMA | Air Voids |
|---------------------------|------------|-------------|--------------|-----------|
| Standard Deviation | | | | |
| Average | 0.83 | 0.12 | 0.39 | 0.43 |
| High | 2.7 | 0.45 | 2.05 | 2.02 |
| Low | 0.01 | 0 | 0.04 | 0 |
| 2 Std. Dev. | 1.66 | 0.24 | 0.78 | 0.86 |
| Spec. | 94.0 ± 2.0 | ± 0.3 | + 2.0 / -0.5 | 4.0 ± 1.0 |

| Pay Factors | | | | | Total |
|--------------------|-----|-------|-------|------|-------|
| Average | 99 | 101.4 | 100.8 | 99.9 | 100.3 |
| High | 105 | 105 | 105 | 105 | 105 |
| Low | 0 | 0 | 0 | 0 | 34.7 |

| | |
|-----------------|---------|
| Tons | 2858666 |
| Projects | 123 |
| Projects Bonus | 64 |
| Projects Deduct | 57 |

Mineral Fillers AASHTO M17

- Challenges
 - Local Sources
 - High Hauling Costs
 - Consistent Supply
 - Lost Production
 - Mix Redesigns

Mineral Fillers

- Types
 - Fine Rock Dust (Traditional)
 - Inadequate Supply
 - Regionally Available
 - Fly Ash
 - Chemical Differences
 - High Loss-on-Ignition?
 - Cement Kiln Dust (CKD)
 - Chemical Differences
 - Can't Use AASHTO T 100
 - But Wait, There's More...

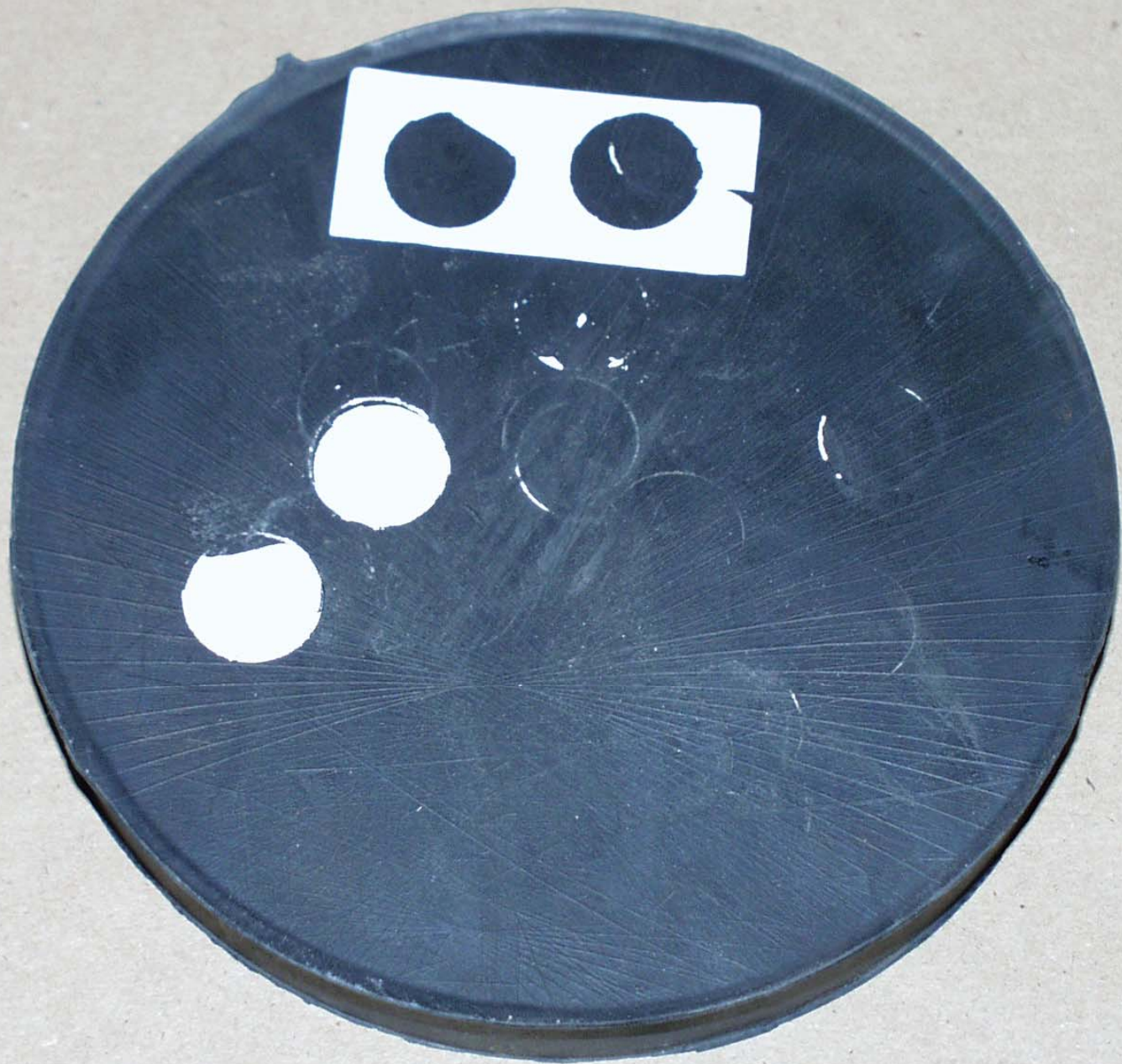
CKD

- High CaO (Quicklime)
 - Antistripping Capabilities?
 - Antioxidant?
- Angular Particles
 - Initial Stiffness of Mixture
 - Limited Amount in SMA

Dust Angularity Measure (Rigden Voids)

- AASHTO MP 8
 - Asphalt Institute, Information Series (IS) 127
 - **403.2.5.1 Filler Restriction.** Rigden void content determined in accordance with MoDOT Test Method TM-73 shall be no greater than 50 percent.





Rigden Voids of Fillers

- Mineral Filler
39 - 47%
- Hydrated Lime
66 - 71%
- Fly Ash
37 - 57%
- CKD
54 - 64%
- Baghouse Fines
30 - 60%

Recycled Asphalt Shingles

- Manufacturing Waste
- Post-Consumer (Tear-Off)

Shingle Components

- Asphalt \Rightarrow 20%-40%
 - Stiffen Roadway Asphalt
- Aggregate \Rightarrow \approx 30%
 - Good Stuff
- Fiberglass or Paper Mat \Rightarrow \approx 30%
 - No Harm if Well Dispersed

MoDOT Goals

- Engineering Properties First
 - Harmful Effects of Deleterious Material
 - Asphalt Binder Properties
- Traffic Safety - Nails, etc.
- If Everything Else Works Out, Landfilling is Reduced

Why Should We Pursue Shingles?

- High Asphalt Content
- Granules Are Hard and Durable
- Recycling **COST**

Concerns

- How Will Deleterious Material Affect the Mixture
- Can the Low Temperature Grading be Maintained at Various Blending Ratios

Binder After Blending with Shingle Asphalt

- Resist Rutting



- Resist Fatigue Cracking



- Resist Cold-Weather Cracking



Asphalt Modifications

PG 64-22 Required

- Stiffer at High Temperature - OK
- Stiffer at Low Temperature
 - Use Lower Percentage of Shingles
 - Use Softer Roadway Asphalt ←

Deleterious Evaluation

- Specification for Aggregate
 - 0.5% "Other Foreign Material"
 - Sticks, mud balls, deer fur, etc.
- Shingle "OFM"
 - Approximately 3% Total

Deleterious Material

- Nails
- Wood
- Plastic
- Cellophane
- Paper
- Fiber Board



No Difference



- Visually
- Standard Mixture Tests
- Placement

Big Difference


- Rut Resistance
- Cold Temperature Tests
- OFM in Fraction



Where Are We?

The "Ex" Factor

- Extrinsic Material Allowance Raised
 - 3.0% Total
 - 1.5% Wood
- Expect PG 64-22 met w/ PG 58-28
 - Extra grades optional w/ testing
 - Examining various proportions and asphalts
- Exuberant Contractors



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