# Hot Mix Asphalt PWL Specifications in Kansas

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# OVERVIEW

- PWL History in Kansas
- PWL Usage (Air Voids)
- PWL Usage (Density)
- Additional Requirements

# PWL History in Kansas

- PWL since October 2000
- ½ the desired incentive/ disincentive
  - Reduce Contractor Risk
- January 2003
  - Density
    - Max Incentive = 4.0%
    - Max Disincentive = 16.0%
  - Air Voids
    - Max Incentive = 3.0%
    - Max Disincentive = 12.0%

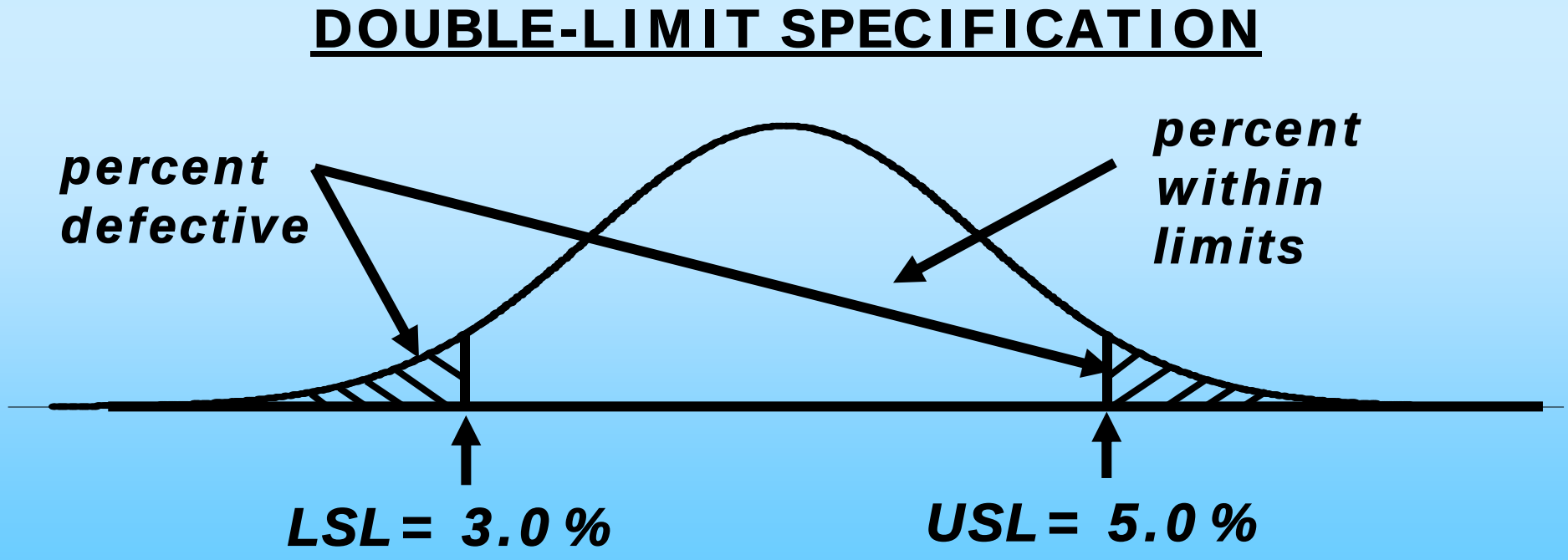
# PWL History in Kansas

- Prior to PWL (06/1996 - 10/2000)
  - Density
    - Tables
      - ½ based on the Avg Density
      - ½ based on Lowest Avg Sublot Density
  - Air Voids
    - Deviation from the target (4.0% @$N_{des}$)

# PWL USAGE (Air Voids)

# PWL USAGE (Air Voids)

- $V_a$ @ $N_{des}$ for all HMA mixes
  - 90 PWL is required for Full Pay (AQL)
  - 50 PWL is RQL



# Comparing the Test Results

- Lot Size Begins at 3,000 Tons
  - 4 Contractor QC Tests per Lot
  - 1 Agency Verification Test per Lot
  - Compare using F&t
- F&t Tests for Air Voids
  - Compare both Variances and Means
  - Significance Level = 0.01
  - Up to 5 Lots of Data Compared
  - Same Means - Use Contractor's Data
  - Different Means - Use Agency's Data

# PWL USAGE (Air Voids)

- $V_a$ PWL Equations
  - Determine Quality Indices

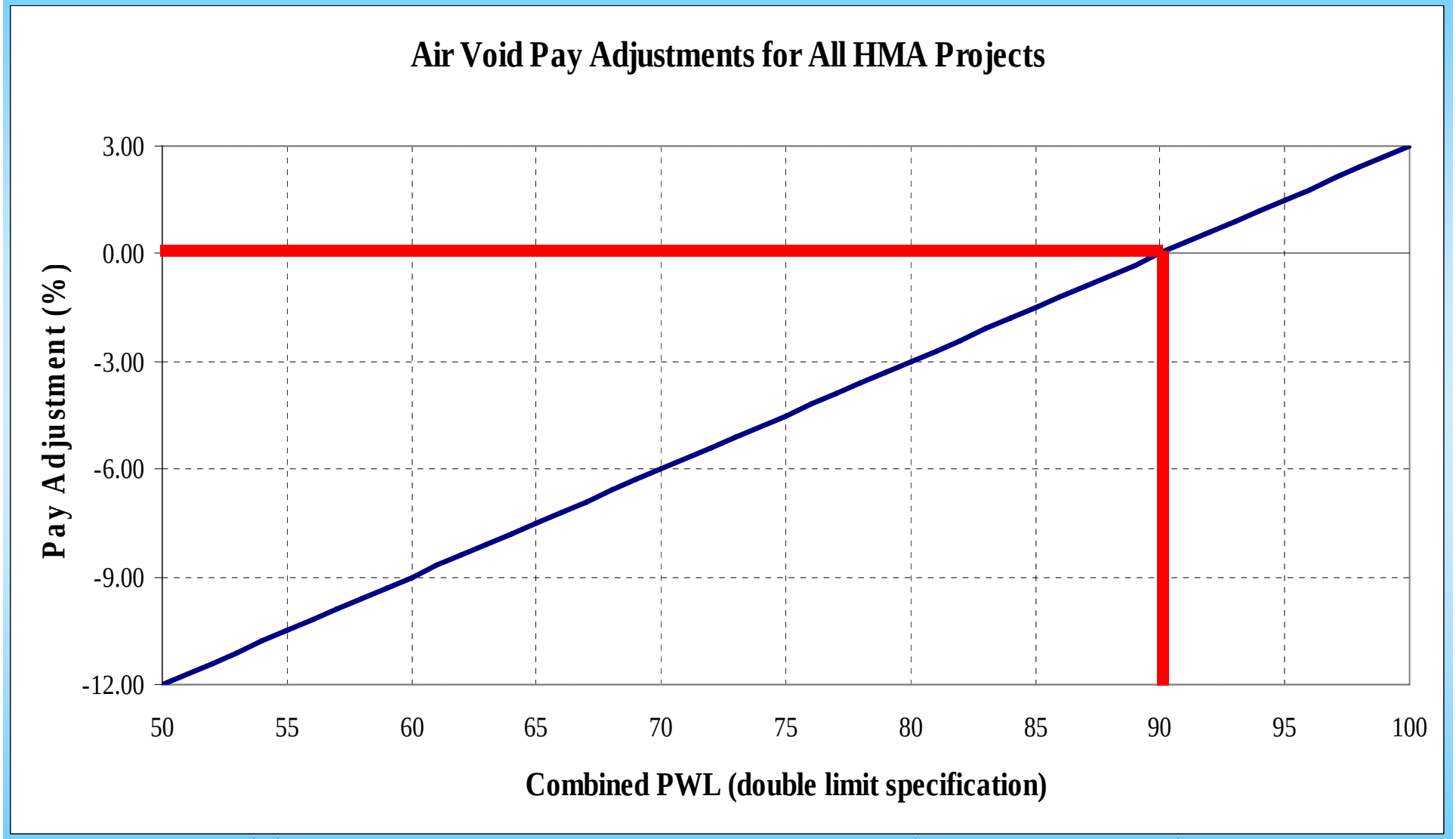
$$Q_{UV} = \frac{USL - \overline{X}}{S} \qquad Q_{LV} = \frac{\overline{X} - LSL}{S}$$

- PWL Equations
  - Find the PWL for both the upper and lower Quality Indices

$$P_V = \left(\left(PWL_{UV} + PWL_{LV} - 100\right) * 0.0030\right) - 0.270$$

Pay Adjustment = Tons in Lot * $40/Ton * Pv

# PWL Usage (Air Voids)




$$P_V = \left( \left( PWL_{UV} + PWL_{LV} - 100 \right) * 0.0030 \right) - 0.270$$

# PWL USAGE (Air Voids)

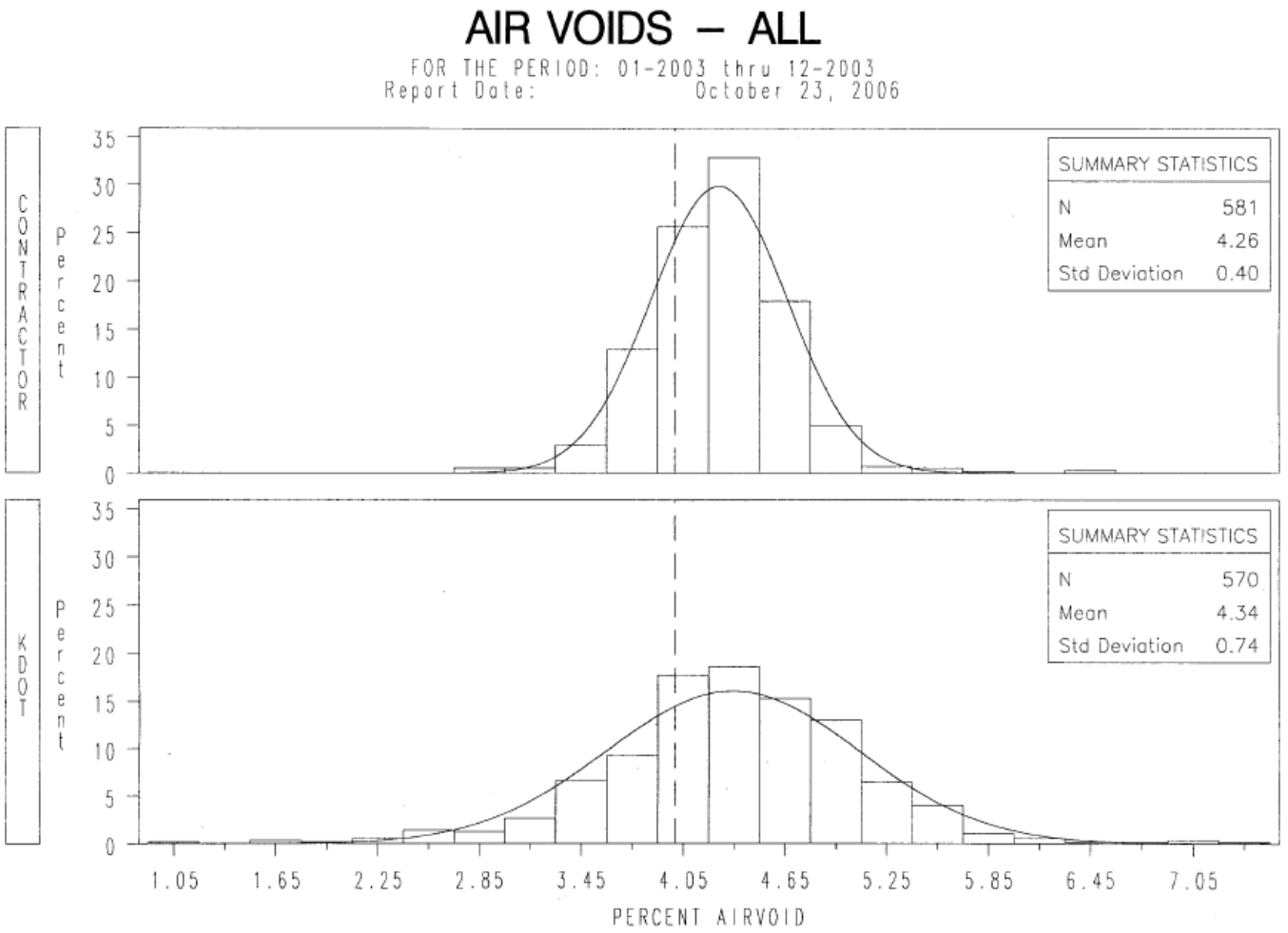
- Combinations of the Average and Standard Deviation that will get maximum bonus

| Average | Max Standard Deviation |
|---|---|
| 3.1 | 0.07 |
| 3.5 | 0.33 |
| 4.0 | 0.66 |
| **4.2** | **0.53** |
| 4.5 | 0.33 |
| 4.9 | 0.07 |

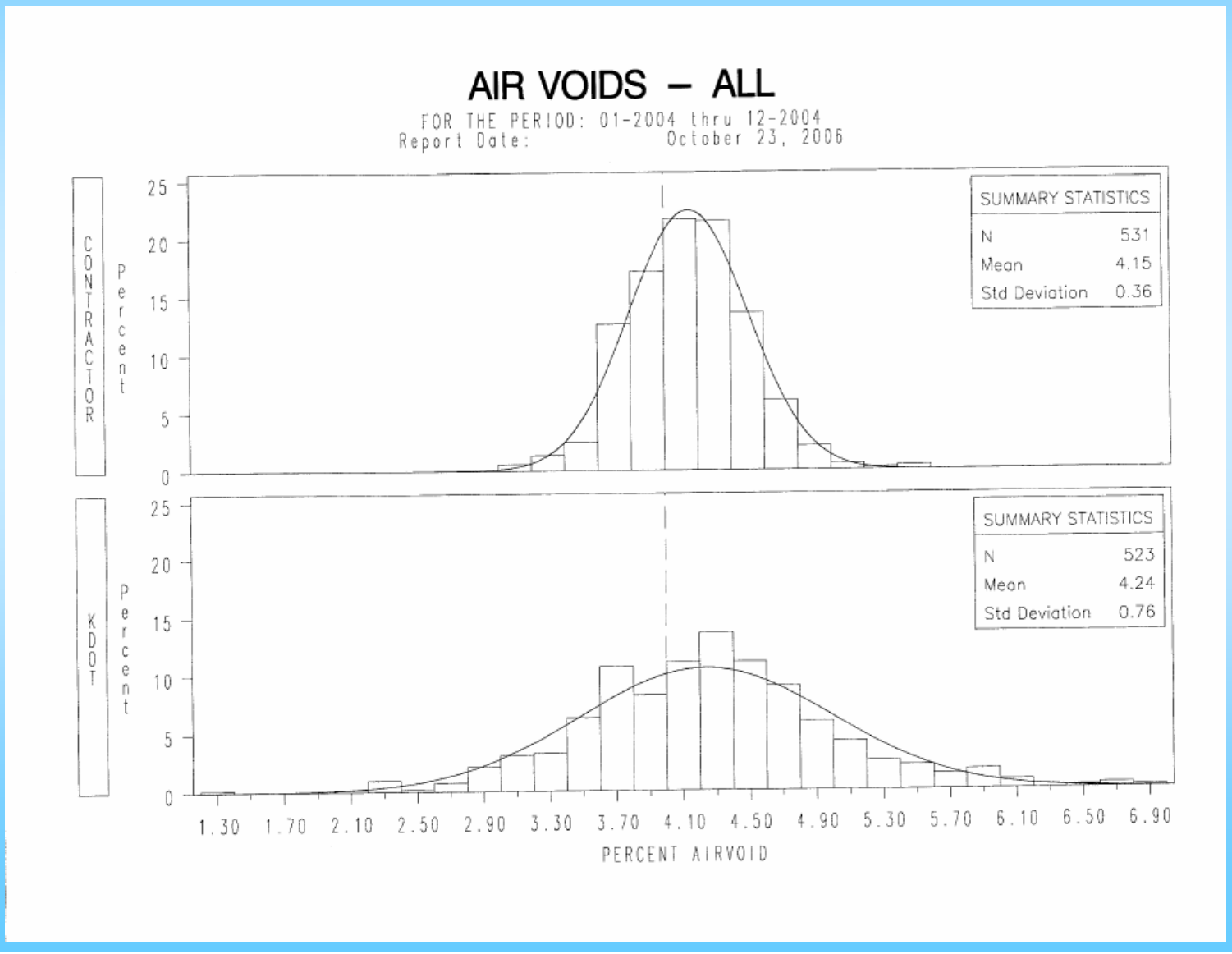
# PWL USAGE (Air Voids)

| | Contractor | | | Agency | | |
|---|---|---|---|---|---|---|
| Year | N | Mean | Std Dev | N | Mean | Std Dev |
| 2003 | 581 | 4.26 | 0.40 | 570 | 4.34 | 0.74 |
| 2004 | 531 | 4.15 | 0.36 | 523 | 4.24 | 0.76 |
| 2005 | 527 | 4.18 | 0.35 | 524 | 4.26 | 0.67 |
| 2006 | 158 | 4.22 | 0.30 | 156 | 4.17 | 0.66 |
| AVG | | 4.20 | | | 4.25 | |

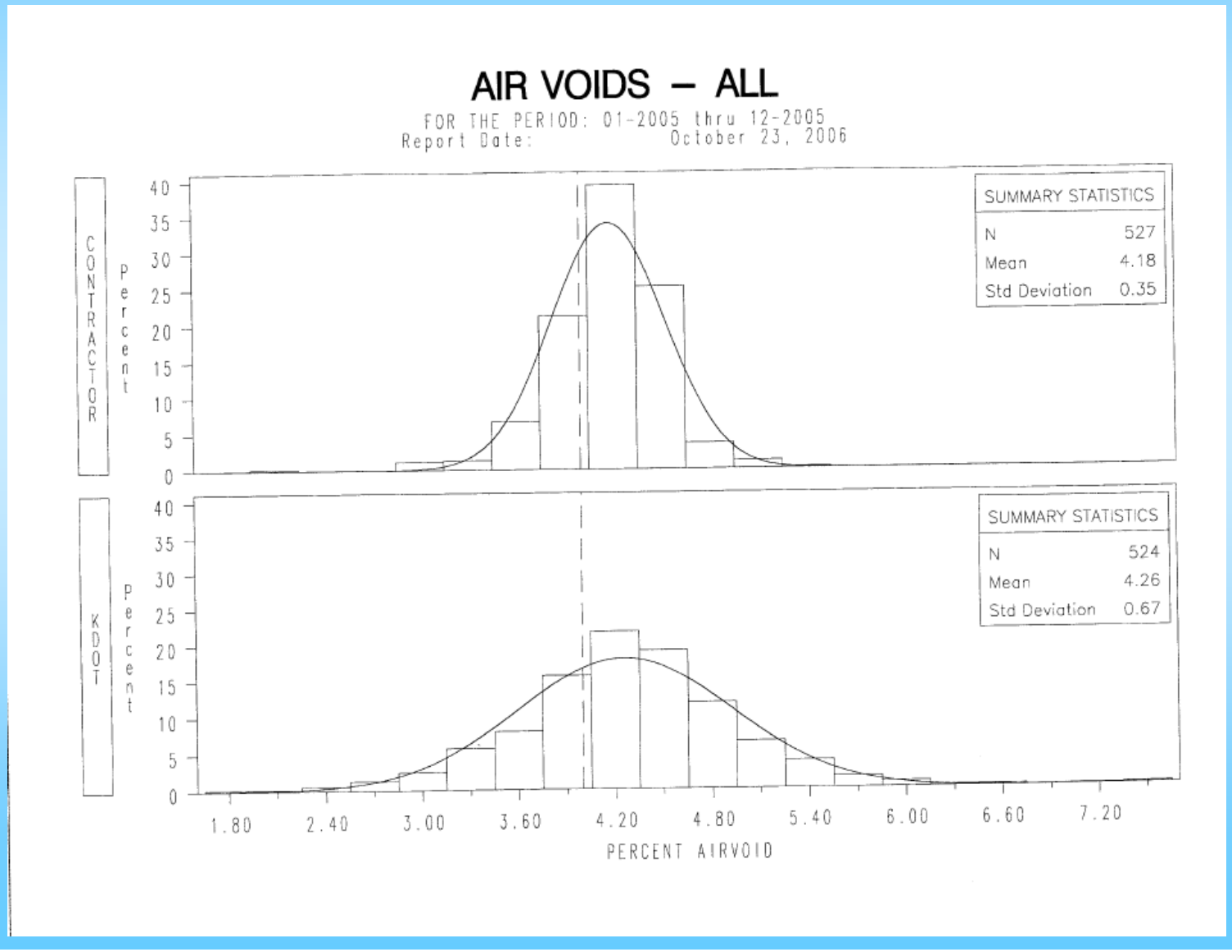
# Va PWL Yearly Comparisons 2003



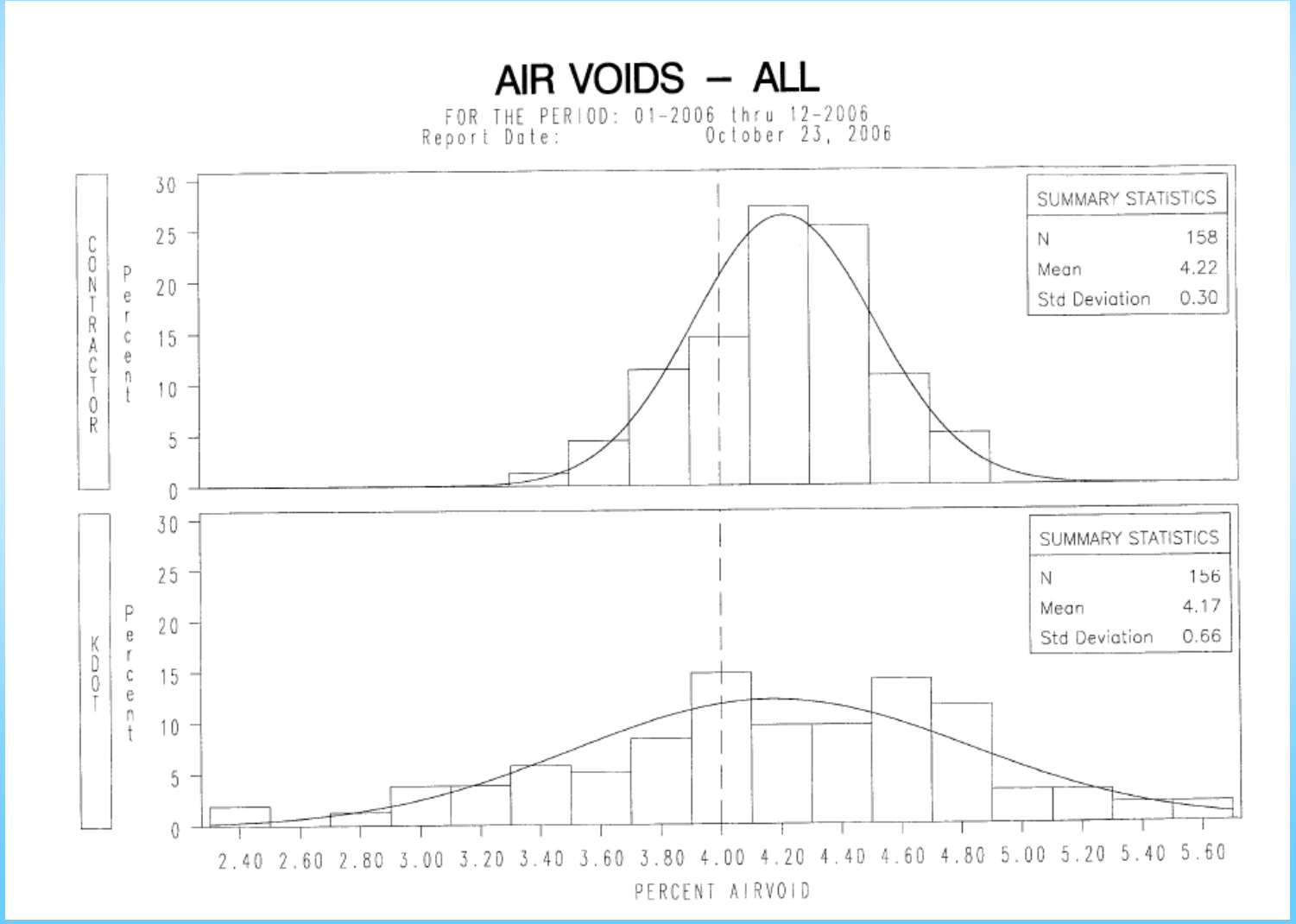
# Va PWL Yearly Comparisons 2004



# Va PWL Yearly Comparisons 2005



# Va PWL Yearly Comparisons 2006



# Yearly Comparisons
# Air Voids

| Year | Earned Incentive | Maximum Incentive | % of Max |
|---|---|---|---|
| 2003 | $169,233 | $ 375,092 | 45% |
| 2003(1/2) | $285,410 | $ 376,541 | 76% |
| 2004 | $895,853 | $1,541,712 | 58% |
| 2005 | $873,705 | $1,661,944 | 53% |
| 2006 | $344,074 | $ 499,309 | 69% |

# PWL USAGE (Density)

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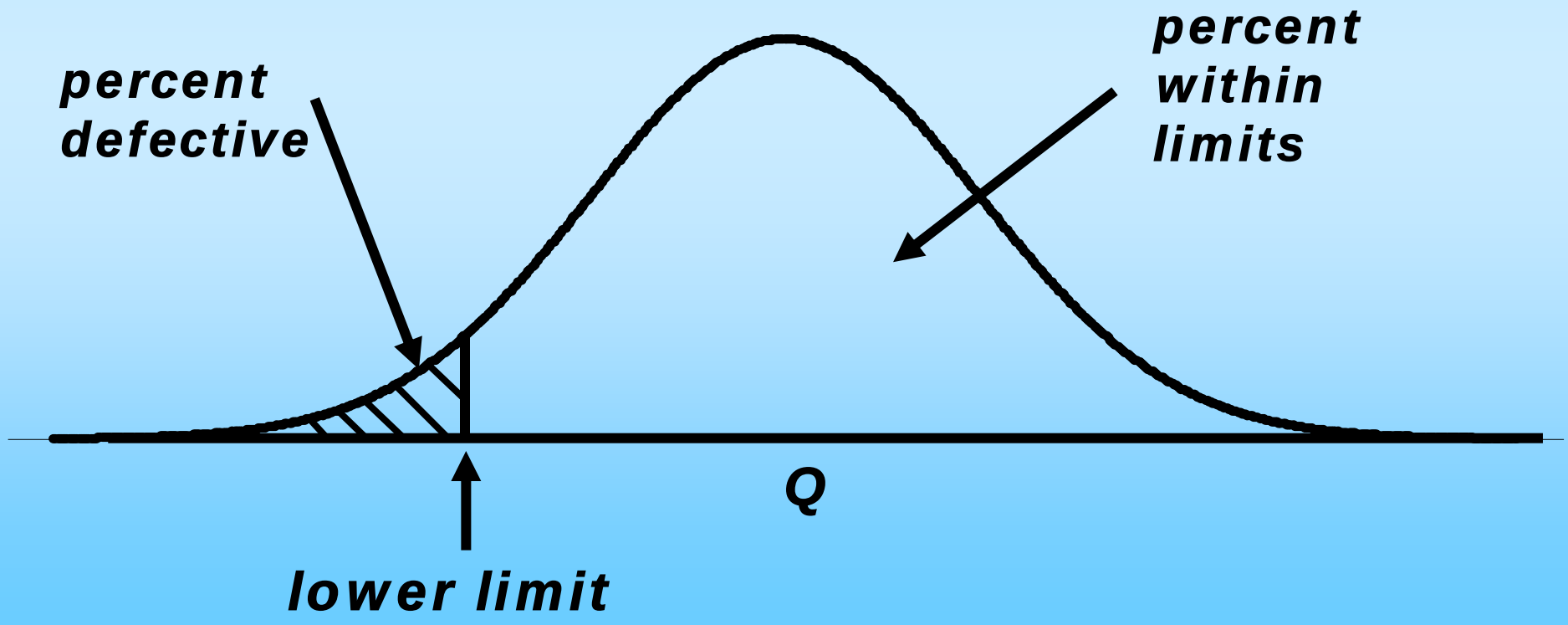
- In-Place Density (%$G_{mm}$)
  - 90 PWL is required for Full Pay (AQL)
  - 50 PWL is RQL
  - One-Sided Specification
    - LSL = 91.0% (Thickness ≤ 2”)
    - LSL = 92.0% (Thickness > 2”)
    - Lot Size is a Day’s Production
    - 10 Contractor QC Tests per Lot
    - 5 Agency Verification Test per Lot
    - Compared using F&t
- Only Used on Major Modification Projects (3R and 4R)

# PWL USAGE (Density)

## SINGLE-LIMIT SPECIFICATION



# Testing

- Typically Using Nuclear Density Gauges
- Cores may be cut and $G_{mb}$ determined
- Day's Production is Divided into 5 Sublots
  - 2 Contractor QC Tests per Sublot
  - 1 Agency Verification Test per Sublot

# Comparing the Test Results

- F&t Tests for Density
  - Compare both Variances and Means
  - Significance Level = 0.01
  - **One** Lot of Data Compared
  - Same Means - Use Contractor's Data
  - Different Means - Use Agency's Data

# PWL USAGE (Density)

- Density PWL Equations
  - Determine Quality Index

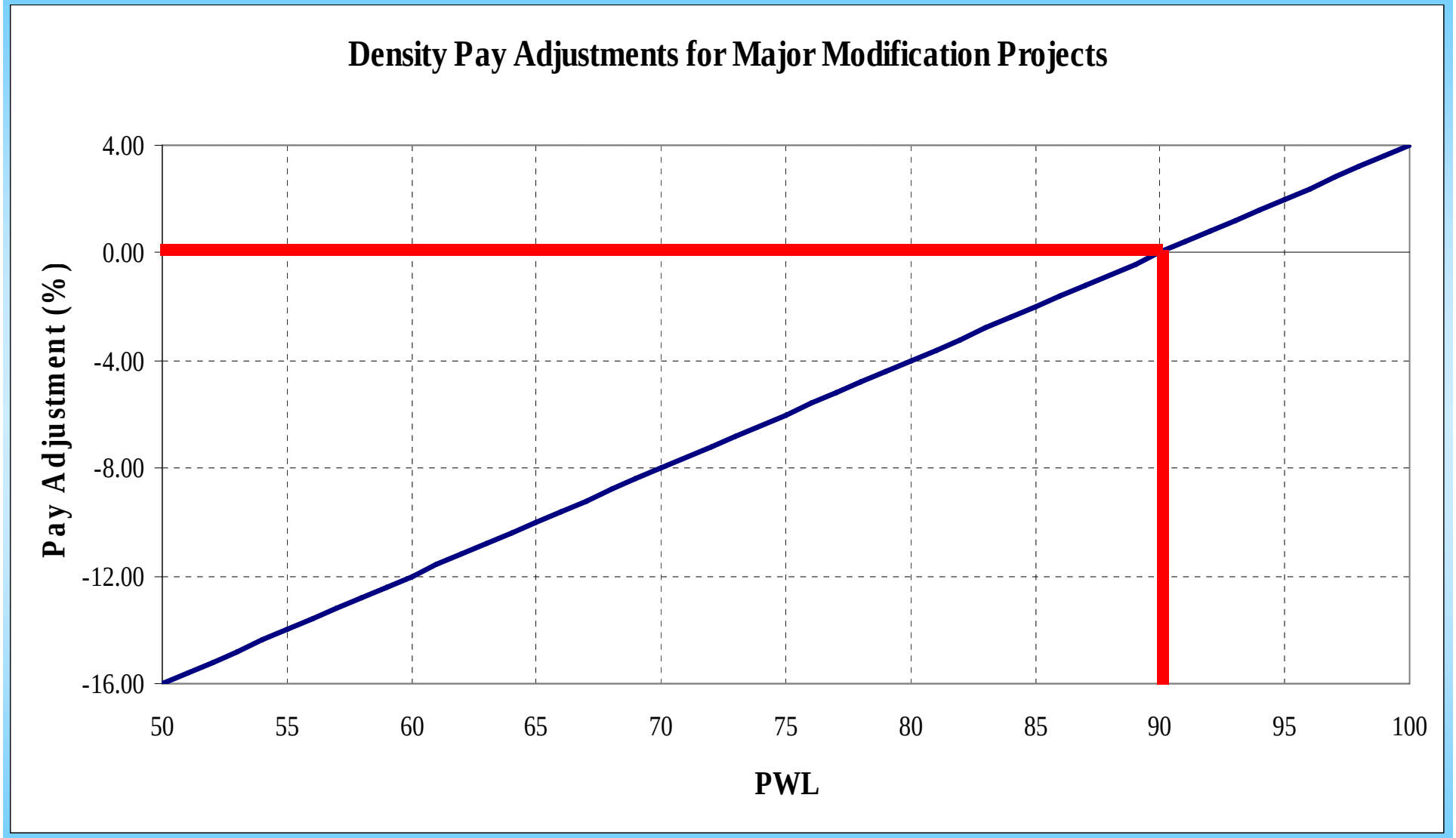
$$Q_{LD} = \frac{\overline{X} - LSL}{S}$$

- PWL Equations
  - Find the PWL lower Quality Index

$$P_D = \left(PWL_{LD} * 0.004\right) - 0.360$$

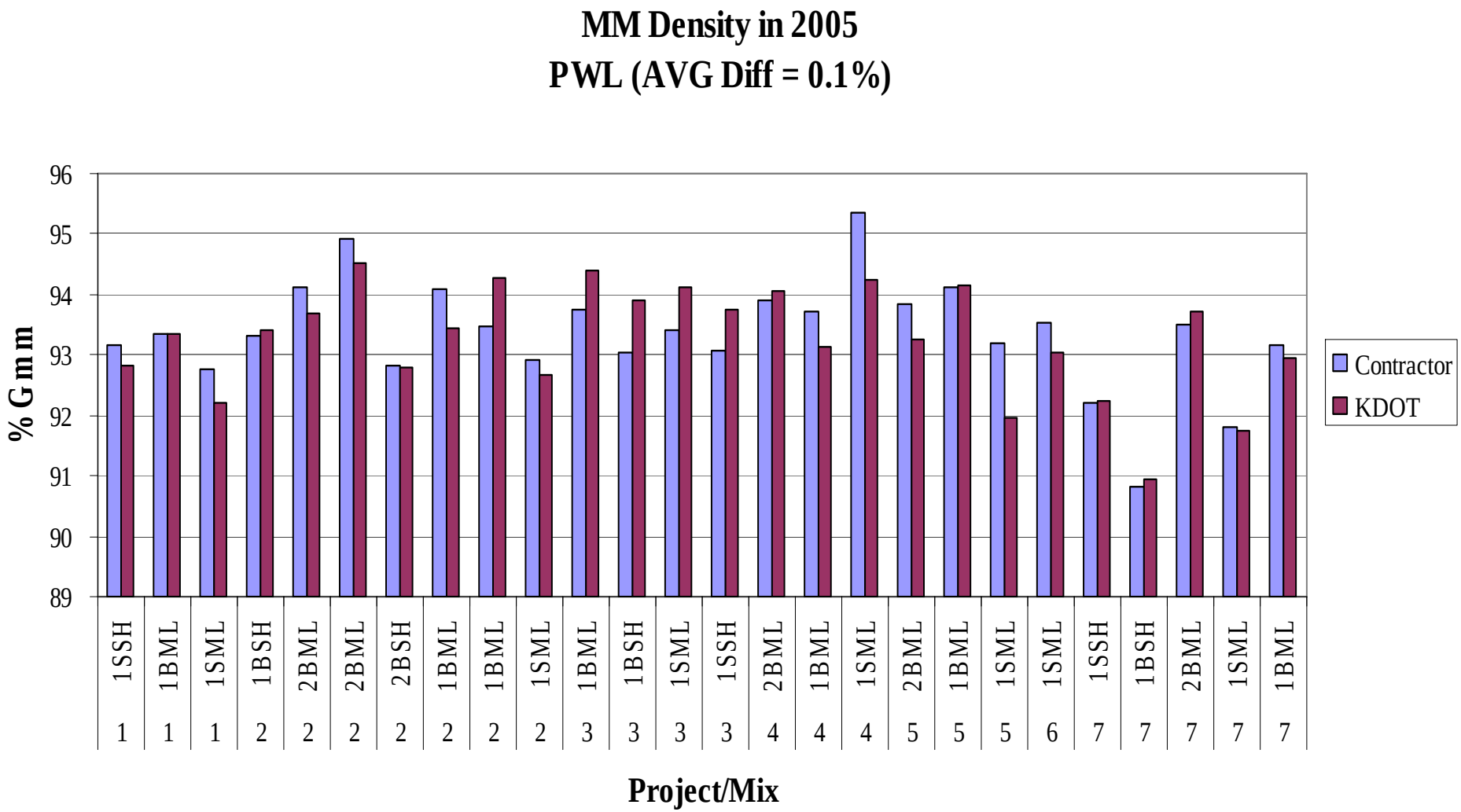
Pay Adjustment = Tons in Lot * \$40/Ton * $P_D$

# PWL Usage (Density)

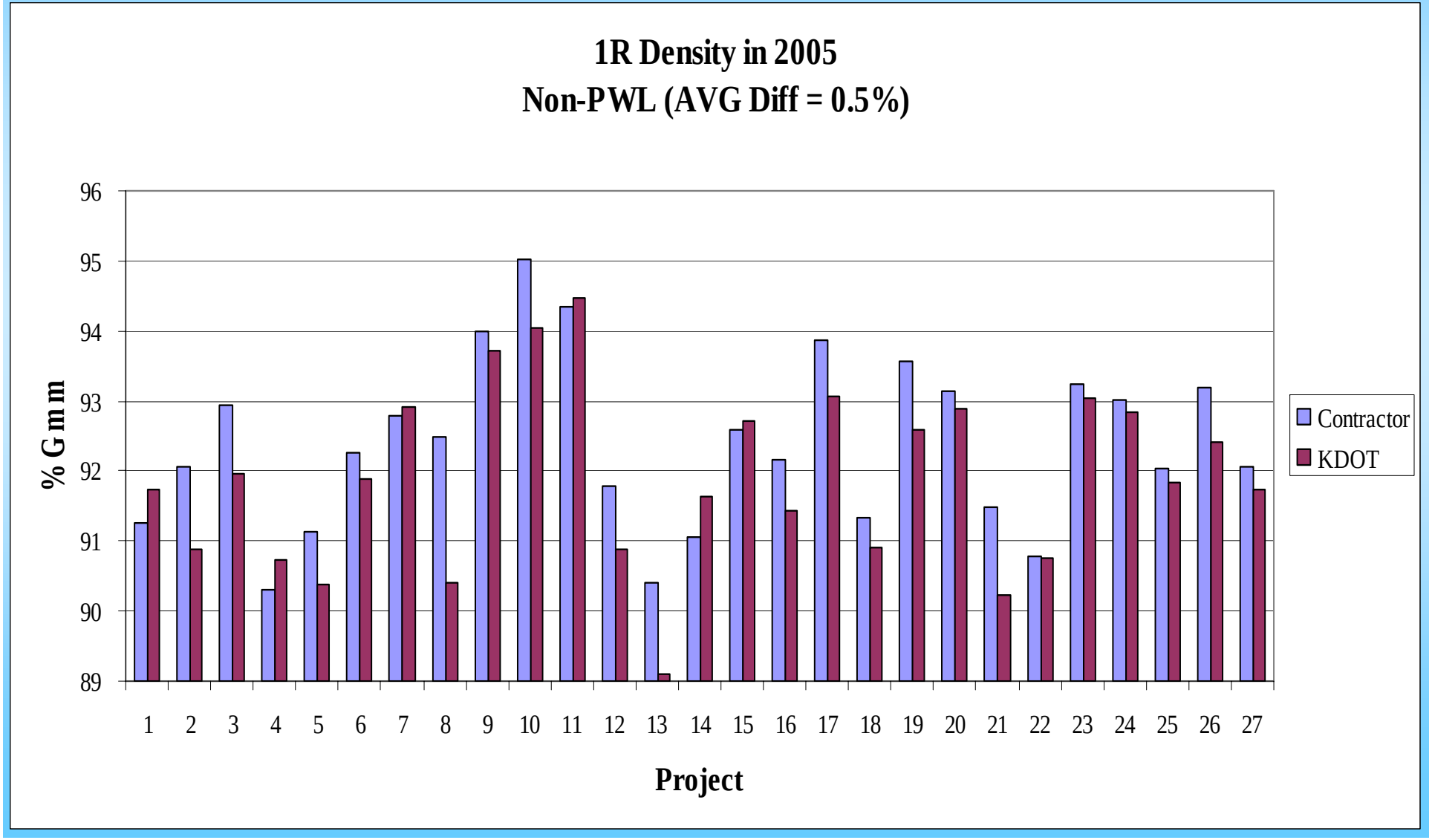



$$P_D = \left(PWL_{LD} * 0.004\right) - 0.360$$

# Density PWL Comparisons 2005 (Avg Diff = 0.1%)



# Density Non-PWL Comparisons 2005 (Avg Diff = 0.5%)



# PWL Usage (Thickness)

- Not QC/QA Testing
- All measurements done by agency
- 5 Sublots per Lot
- 90 PWL is full pay (AQL)
- 50 PWL is RQL
- LSL
  - Mainline = Plan Thickness - ½”
  - Shoulder = Plan Thickness - ¾”
- Max Incentive = 3.0%
- Max Disincentive = 12.0%

# Additional Requirements

- Technician Certification Program
  - KSU (Salina and Manhattan)
  - National Certifications
  - KDOT Training
- Laboratory Certification Program
  - AASHTO Accredited (AAP)
- Equipment Calibration Program
  - NIST Traceable equipment
- Independent Assurance Testing
- Inspection
- Contractors Involved in Process

# Conclusions

Pay Adjustments using PWL tend to tighten the Contractor's Process Control

The incentives and disincentives should be balanced and fair

Involve Partners in the Implementation and Refinement of the Specifications

Include a Certification Program

Continue Project Inspection

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## Questions?