

Percent Within Limits (PWL) Implementation for HMA Acceptance in Connecticut

*North East States Materials Engineer Association
94th Annual Meeting*



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Overview

- HMA testing in Connecticut
 - In-place Density
 - Testing Process
 - Specification Requirements
 - Percent Within Limits (PWL) *New!*
 - Mixture
 - Testing Process
 - Specification Requirements
 - Sampling at the Paver *New!*
- Summary
- Questions



History - In-place Density

2009

- **Prior to 2009:**
 - Nuclear gauge
 - Lot = each day of production
 - 10 to 20 density readings/locations per day
 - Density adjustment for each lot based on the average density

TABLE 6 - Mat and Longitudinal Joint Adjustments

Average % Density	% Adjustment (PA)
97.1 – 100	-2.5
92.0 – 97.0	0.0
91.0 – 91.9	-2.5
89.1 – 90.9	-5.0
87.0 – 89.0	-30
86.9 or less	-50 or rejection

Weighted Average 40% Mat, 60% Joint



History - In-place Density

2009

- **2009:** Positive adjustment and bridge lots added

ADJUSTMENT VALUES FOR PAVEMENT DENSITY

Average % Density	% Adjustment for non-bridge lots	% Adjustment for bridge lots
97.1 – 100	-2.5	- 2.5
94.5 – 97.0	+2.5	+2.5
92.0 – 94.4	0.0	0.0
91.0 – 91.9	-2.5	- 10.0
89.1 – 90.9	-15.0	- 30.0
87.0 – 89.0	-30.0	- 50 or Remove and Replace
86.9 or less	Remove and Replace	Remove and Replace

Weighted Average 40% Mat, 60% Joint



History - In-place Density

2011

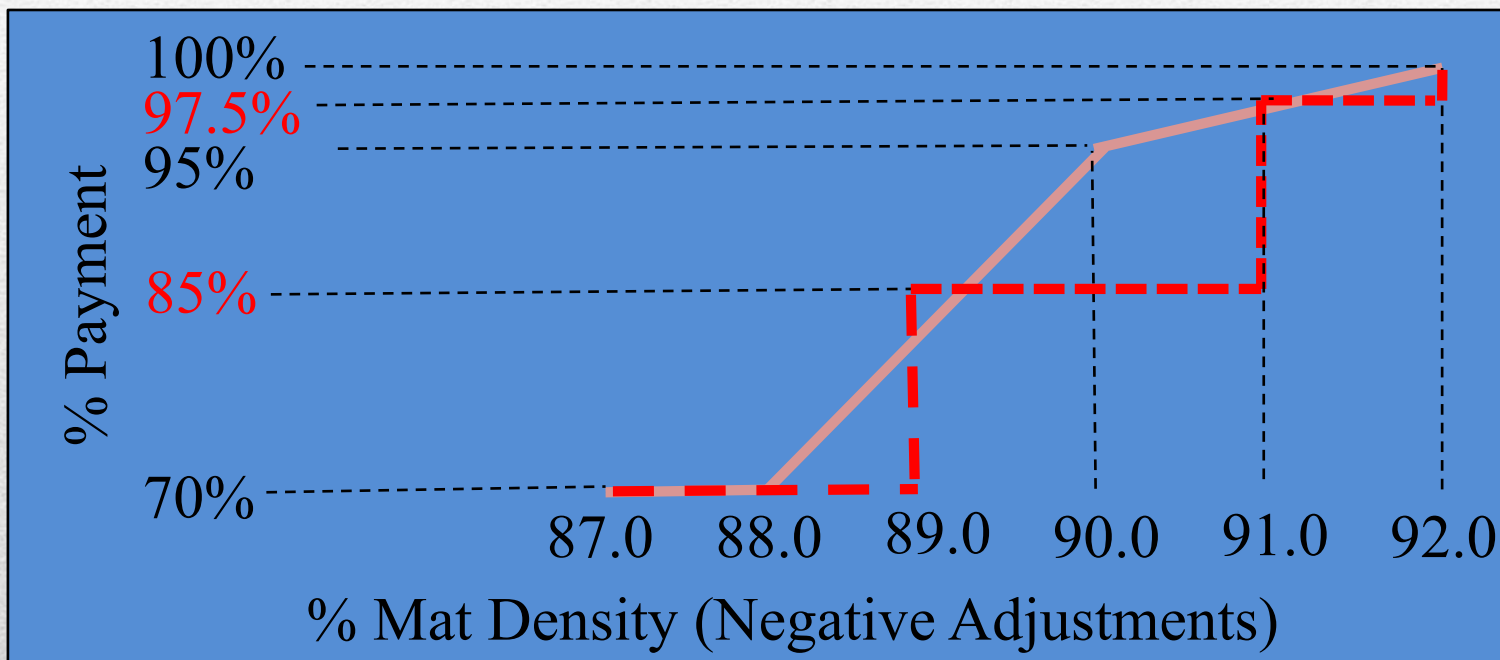
- 2011:
 - Field Cores by AASHTO T 331
 - Lot = curb-to-curb (approximately 2000 tons)
 - 4 Mat and 4 Joint cores per each lot



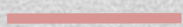
History - In-place Density

2013

- **2013:** Some roadway and bridge lots were combined. Adjustments changed from stepped to continuous.



2013



2011

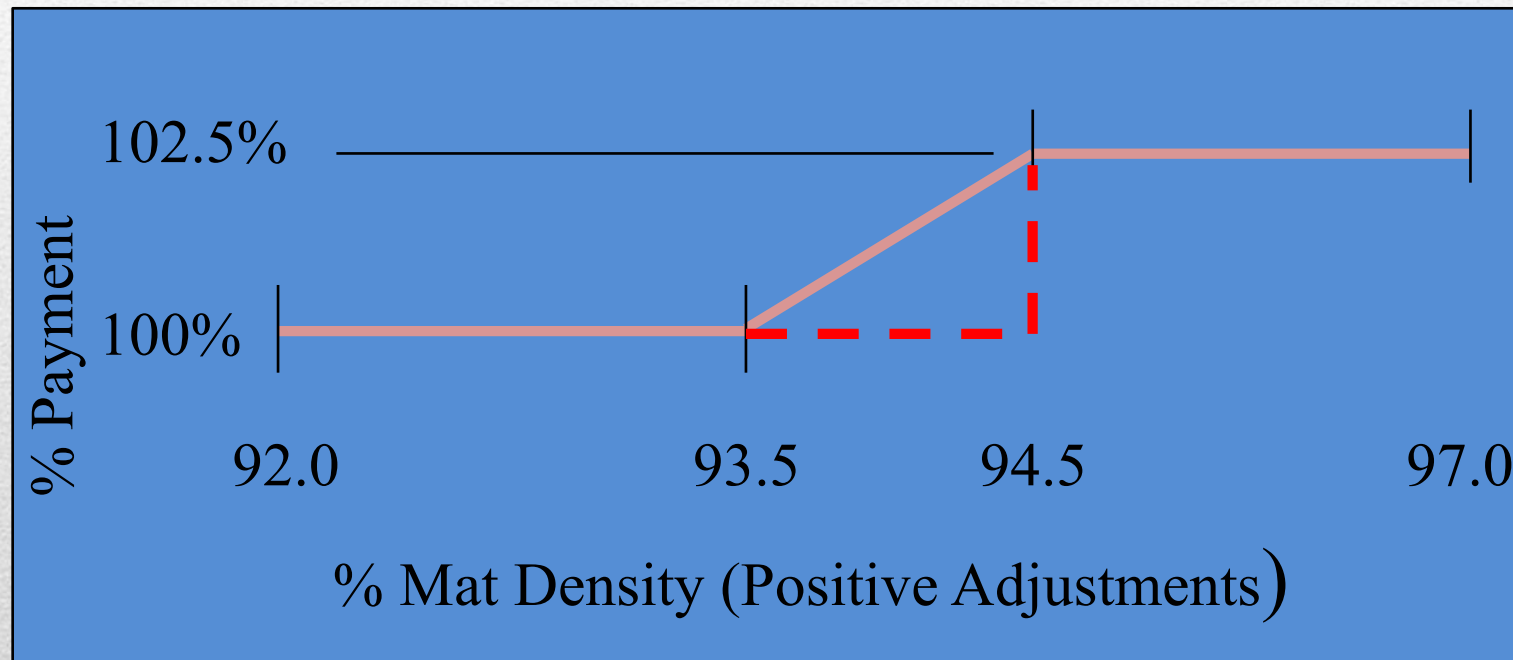


Weighted Average 50% Mat, 50% Joint



History - In-place Density

2013



2013

2011

Weighted Average 50% Mat, 50% Joint



History - In-place Density

2013

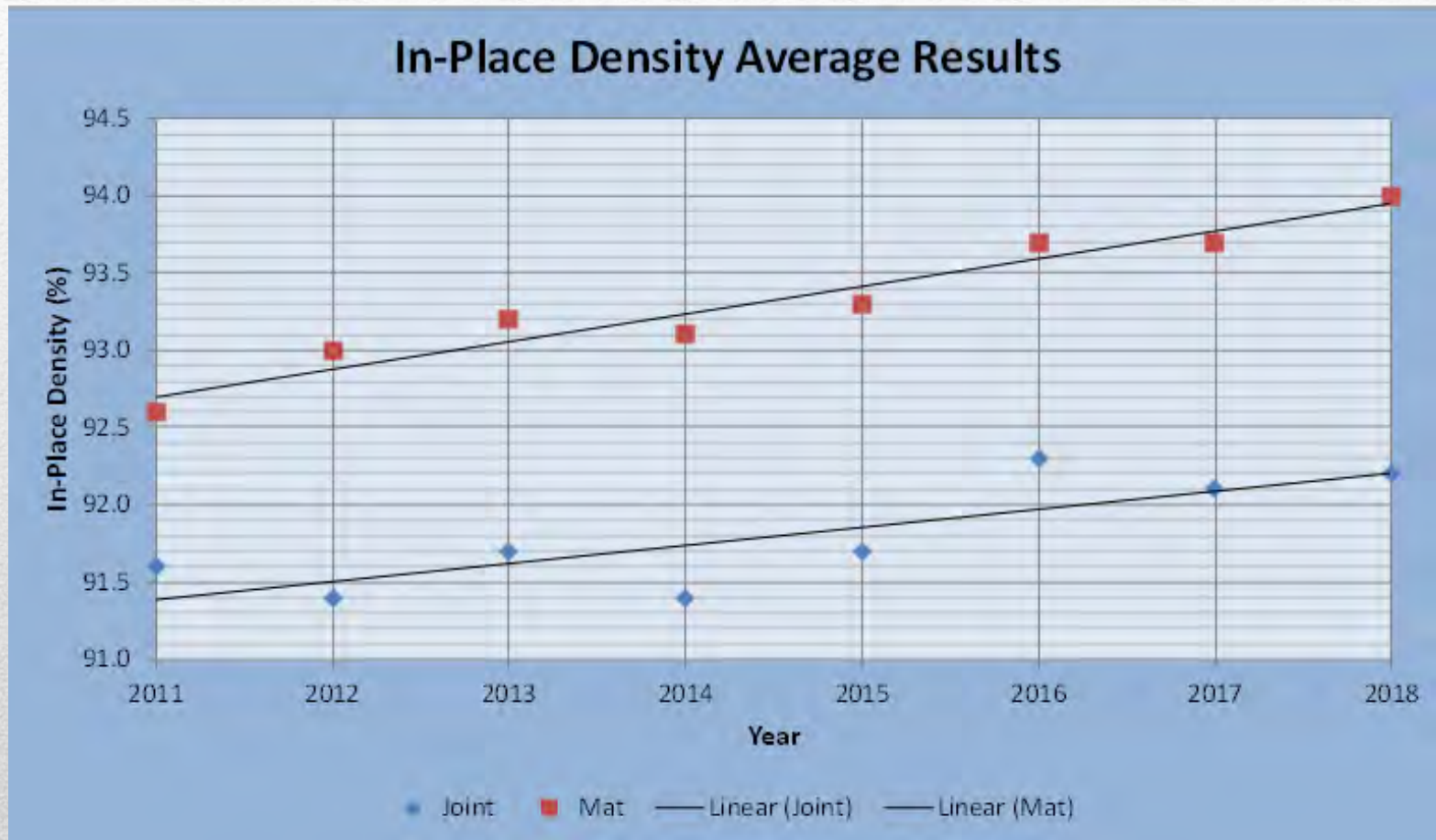
Analysis Method	Simple Average
Lot Size	2000 tons
Analysis Area	Curb-to-curb
Cores	
Standard Lot (no bridges)	<500 tons: 3 Mat - 3 Joint
	>500 tons: 4 Mat - 4 Joint
Combo Lot (w/decks <500' long)	<500 tons: 2 Mat - 2 Joint (+1 each on bridge ≤300 feet) (+2 on bridge 301 to 500 feet)
	>500 tons: 4 Mat - 4 Joint (+1 each on bridge ≤300 feet) (+2 on bridge 301 to 500 feet)
Bridge Lot (only decks >500' long)	Depending on length varies from 2 Mat & 2 Joint to 5 Mat & 5 Joint



In-Place Density - Roadway

2011

2018



1.5% increase in Mat

0.7% increase in Joint



In-Place Density Increase

Important Factors:

- Consistent measurement method (AASHTO T 331) since 2011
- ConnDOT performs all testing in one location with experienced staff
- Contractor is responsible for obtaining core samples as directed
- Adjustments via a continuous function with a lower incentive threshold
- Statewide Density Summary report provided to Industry annually
- Continuous improvement of Specifications



In-Place Density Changes for 2019 *New!*

HMA Project Quantity (Per mix)	>3500 tons
Lot Size	Mat Density Lot (Each 3500 tons*) - Joint Density Lot (Each 14,000 feet*)
Analysis Method	PWL
Analysis Area	tons placed (one pass or curb-to-curb)
Cores	
Standard Lot (no bridges)	7 Mat cores per mat density lot (1 per 500 tons - stratified random)
	7 Joint cores per joint density lot (1 per 2000 feet - stratified random)
Combo Lot (w/decks <500' long)	Not Applicable
Analysis Method	Simple Average
Bridge Lot (only decks)	Varies from 2 Mat & 2 Joint to 5 Mat & 5 Joint depending on length

* partial lots (<3,500 tons, or <14,000 feet) may be used if material completes a course or 30 days have passed since initial placement of material in the lot.



In-Place Density Changes for 2019 *New!*

2019

- **Specification limits:**

2019 (Simple Average <3500 tons)

2019	LSL	USL
Mat	92	97
Joint	91	97

2019 (PWL >3500 tons)

2019	LSL	USL
Mat	91.5	98
Joint	90	98

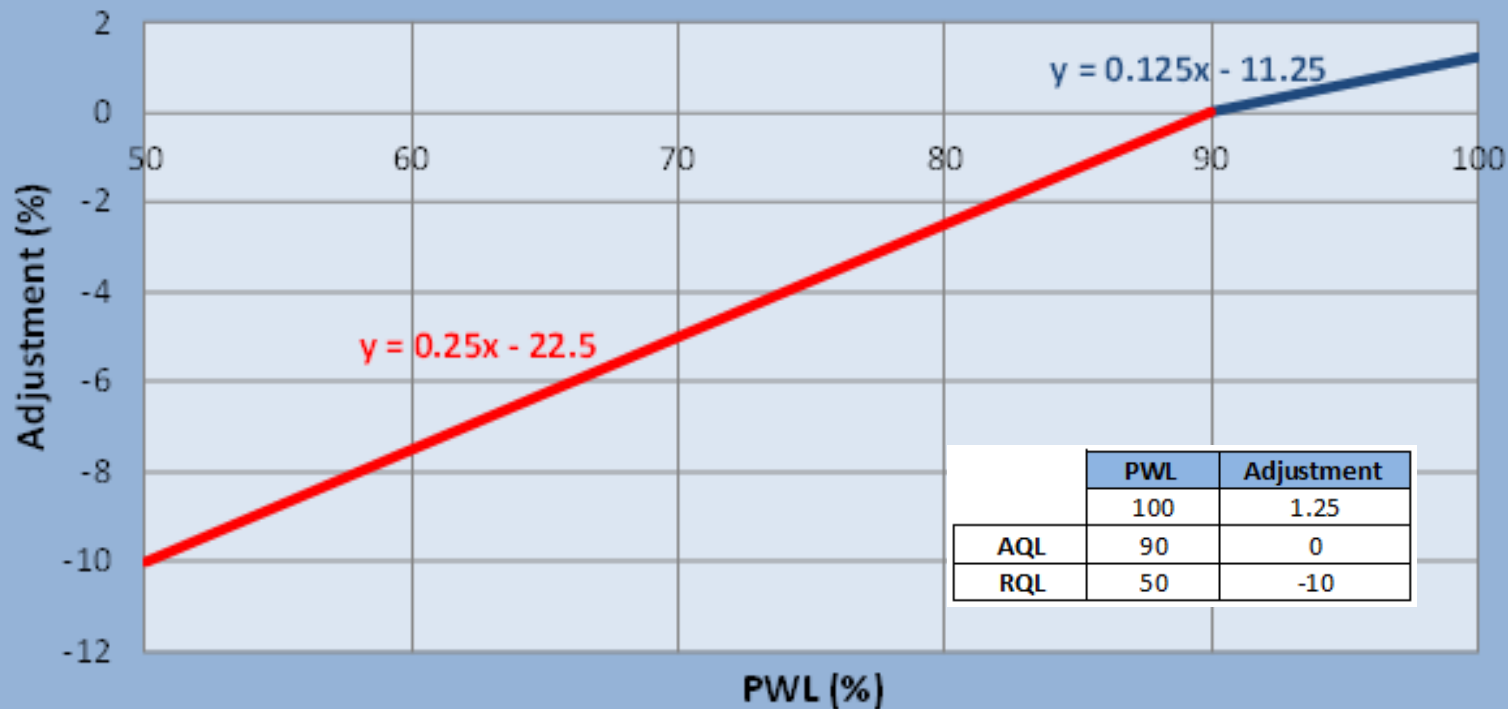
- **Justification:**

- FHWA Stewardship Audit Spring 2018
- Analyzing 2016 & 2017 data with 2019 specification



In-Place Density Changes for 2019 *New!*

In-Place Density Adjustments (Mat or Joint)



History - Mixture Acceptance

2009

- **Prior to 2009:**
 - Lot = each day of production
 - Gradation and binder content used as acceptance criteria
 - No positive adjustments
 - Negative adjustment (10%) applied to material outside the criteria



Photo Courtesy of Tilcon Connecticut



History - Mixture Acceptance

2009

- **2009:**
 - Air Voids and Binder Content used as acceptance criteria
 - Positive or negative adjustments based on deviation from target in air voids
 - 10% negative adjustment if below minimum binder requirement
 - Stepped adjustment criteria



History - Mixture Acceptance

2013

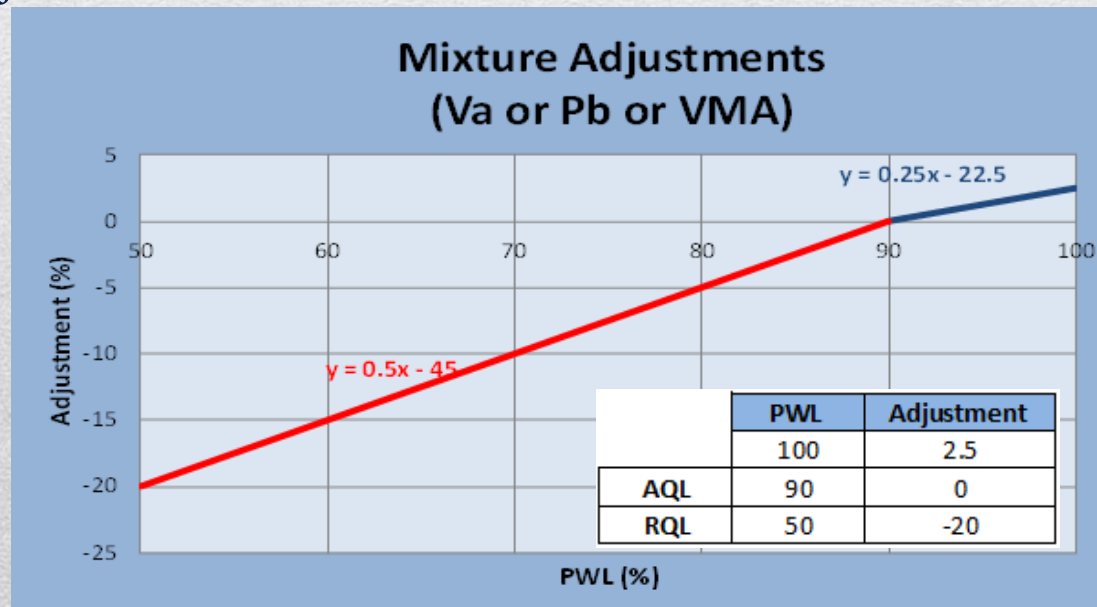
- **2013:**
 - Stepped adjustment criteria changed to continuous
 - Air Voids (V_a)
 - Max Positive sub-lot Adjustment (2.5%) - $3.8\% < V_a < 4.2\%$
 - Max Negative sub-lot Adjustment (20%) - $V_a < 2.2\%$ or $V_a > 5.8\%$
 - Binder Content (P_b)
 - 0% Equal to or above minimum per sub-lot
 - -10% Below the minimum per sub-lot
 - Overall adjustment was the average of the sub-lot adjustments



History - Mixture Acceptance

2017

- 2017:
 - No changes for projects < 3500 tons
 - PWL implemented ≥ 3500 tons
 - VMA added as criteria for PWL projects
 - Lot adjustment = $0.5 Va + 0.25 Pb + 0.25 VMA$



History - Mixture Acceptance

2017

- 2017:
 - Specification limits:

(Non PWL <3500 tons)

2017	LSL	USL
Va	3	5
Pb	Min NMAS/level	
VMA	NA	NA

(PWL ≥3500 tons)

2017	LSL	USL
Va	2.8	5.2
Pb	Target-0.4	Target+0.4
VMA	Target-1.3	Target+1.3



Mixture Sampling *New!*



2018 Season:

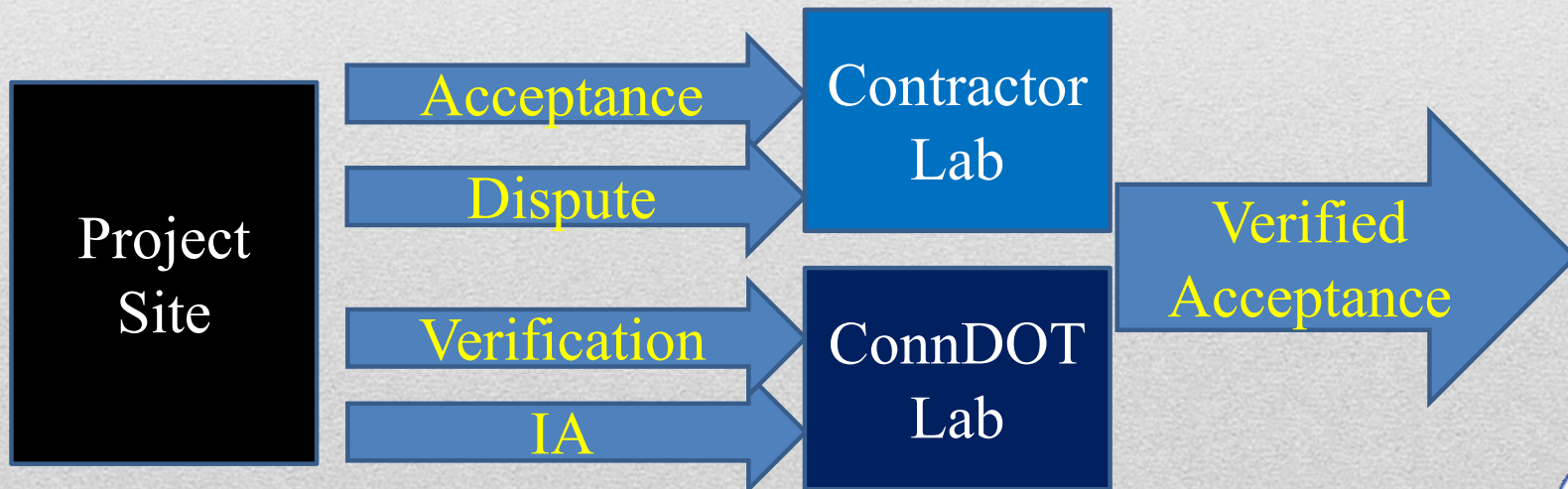
- UCONN CAPLab - study sampling at the project site (paver)
- Six projects
- Behind the screed – Out of wings – Out of paver hopper/MTV



Mixture Acceptance Procedure *New!*

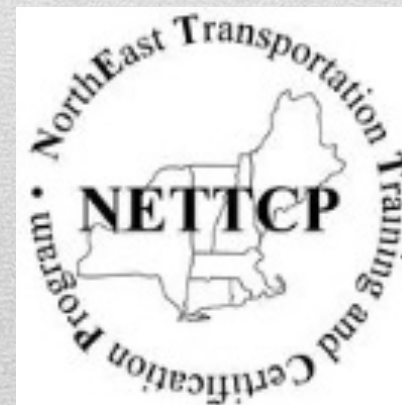
2019 Season:

- Department will witness sampling at the project site (paver)
- Split samples to the Contractor and the Department



Mixture Acceptance Procedure - Current Topics

- Project Sampling Method – open to options proposed by Contractor
- Reheating samples
- Sample security
- Contractor concerns with technician availability
- Sampling certification/qualification



Reasons for Success

- Strong Industry/Agency partnership
- Support from the FHWA, NEAUPG and others
- Measurement techniques and technology have improved
- Statistically based specifications measure quality more accurately
- Payment adjustments reward good quality control
- Other states procedures and specifications provide invaluable lessons



Summary

- HMA testing has evolved, and will continue to do so, due to improvements in technology and resource reductions.
- More accurate quality data leads to less arguing and more focus on controlling the process.
- DOT/Industry communication must be open, continuous, and attentive.



Thanks!



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AND
ASK
QUESTIONS**

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