

Indiana Round Robin



HMA Acceptance

- **Where should the sample be obtained**
- **What properties should be measured**
- **Are the Producer and INDOT obtaining the same test results**
- **What should be the allowable tolerances from the mix design**
- **What penalties or bonuses should be assessed for deviations from the specification requirements**

HMA Acceptance

- **Laboratory Procedures**
- **Field Procedures – PWL**
- **Sampling & Testing Variables**
- **Quality Control Procedures**

HMA Sample Proficiency

- **Purpose – INDOT & Producers**
 - **Verify that Gyrotory Compactors are calibrated**
 - **Verify that procedures for AASHTO T 312 & AASHTO T 166 are correct**
 - **Obtain correct tolerances for variables such as equipment, procedures, and material**
 - **Correct deficiencies prior to Construction season**

HMA Sample Proficiency Information

- **Equipment Calibration Procedure
– Gyratory Compactors**
- **Type of Gyratory Compactor**
- **Variability of Results**

HMA Sample Proficiency 2006

- **96 Laboratories**
 - **21 INDOT Labs – Production Labs & Materials Management**
 - **75 Certified HMA Labs**

HMA Sample Proficiency 2006

- **9.5 mm Surface Mixture**
 - **PG 64-22**
 - **#11 Stone -- 60 %**
 - **Sp. Gr. = 2.728**
 - **Absorption = 1.06%**
 - **#23 Natural Sand -- 40 %**
 - **Sp. Gr. = 2.657**
 - **Absorption = 1.58**

9.5 mm Surface Mixture

Sieve	% Passing	Specifications
12.5 mm	100.0	100.0
9.5 mm	97.0	90.0 – 100.0
4.75 mm	64.0	< 90.0
2.36 mm	38.0	32.0 – 67.0
75 μ m	5.0	2.0 – 10.0

HMA Sample Proficiency

- One Technician batched all samples
- Requirements for Labs
 - Condition @ 275 °F for 4h stirring every 60 ± 5 min
 - 100 gyrations
 - Measure height at N_{ini} and N_{des}
 - Measure Bulk Specific Gravity— AASHTO T 166

HMA Sample Proficiency

- **Gyratory Manufacturer and Model**
- **Internal Angle Verification Method**
 - **RAM**
 - **DAV**
 - **DAV II**

Gyratory Compactors

- **INDOT – Baby Pine (AFG1A) -- 21**
- **Producers**
 - **Baby Pine (AFG1A) -- 33**
 - **Pine (125X) -- 12**
 - **Troxler (4140) -- 20**
 - **Troxler (4141) -- 6**
 - **Gilson Brovold -- 2**
 - **Pine Brovold -- 1**
 - **Gilson (BGC1) -- 1**



Gyratory – Internal Angle

$1.16 \pm 0.02^\circ$

- **RAM**
 - **INDOT -- 21**
 - **Producers -- 38**
- **DAV**
 - **Producers -- 14**
- **DAV II**
 - **Producers -- 23**



Precision and Bias

- **d2s limit (“difference two-sigma limit”)** – maximum acceptable difference between two results obtained on test portions of the same material

HMA Sample Proficiency Results

Property	AMRL-2004 (392 Labs)	AMRL-2005 (424 labs)	INDIANA (96 Labs)
	1s	1s	1s
Gmb	0.031	0.024	0.012
% Gmm	1.3	1.1	0.50
N_{ini}	2.3	1.5	1.0
N_{des}	1.6	1.5	0.8

Multilaboratory Precision (CA < 1.50 % Absorption)

Property	AASHTO T 312 (2004)		INDIANA (2006-96 Labs)	
	1s	d2s	1s	d2s
% Gmm 12.5 mm	0.6	1.7	--	--
% Gmm 19.0 mm	0.6	1.7	--	--
% Gmm 9.5mm	--	--	0.5	1.4

HMA Sample Proficiency Results

Property	INDOT (42 samples)		Producers (150 samples)	
	Avg.	1s	Avg.	1s
Gmb	2.372	0.015	2.372	0.012
% Gmm	95.1	0.612	95.1	0.469
Nini (mm)	127.22	0.8	126.98	1.1
Ndes (mm)	118.46	0.7	118.23	0.8

HMA Sample Proficiency Results

Average of Two Samples

Property	INDOT		Producers	
	1s	1s	1s	1s
	21	42	75	150
Gmb	0.013	0.015	0.010	0.012
% Gmm	0.517	0.612	0.410	0.469

INDOT Sample Proficiency Results

Property	INDOT 2004 (19 Labs)	INDOT 2005 (17 Labs)	INDOT 2006 (21 Labs)
	1s	1s	1s
Gmb	0.015	0.007	0.015

Gyratory Compactors

Compactor	Samples	BSG	1s
Baby Pine	112	2.371	0.014
Pine	24	2.377	0.010
Troxler 4140	40	2.371	0.012
Troxler 4141	12	2.375	0.006
Others	8	2.374	0.007

Ratings

- 5 -- $\pm 1.0 \sigma$ from the mean
- 4 -- $\pm 1.5 \sigma$ from the mean
- 3 -- $\pm 2.0 \sigma$ from the mean
- 2 -- $\pm 2.5 \sigma$ from the mean
- 1 -- $\pm 3.0 \sigma$ from the mean
- 0 -- 3.0 or more σ 's from the mean

HMA Sample Exchange 2007

- **All INDOT and Certified HMA Producer Labs**
- **Compaction, Bulk Specific Gravity, and Maximum Specific Gravity**
- **19.0 mm Intermediate**
- **Aggregate Absorption ≥ 1.50 %**
- **Rate Labs and Correct Deficiencies Prior to Construction Season**

HMA Acceptance

- **Laboratory Procedures**
- **Field Procedures – PWL**
- **Sampling & Testing Variables**
- **Quality Control Procedures**

Plate Sampling

- **Point - of - Use**
- **Random Location**
- **Addresses**
- **Segregation**
- **Storage**
- **Loading Trucks**
- **Unloading Trucks**
- **Paver Operation**



Plate Sampling

- **Problems**
 - **Mars Surface**
 - **Size of Sample**
 - **Loss of Material from plate**
 - **Transporting Sample and delay of test results**

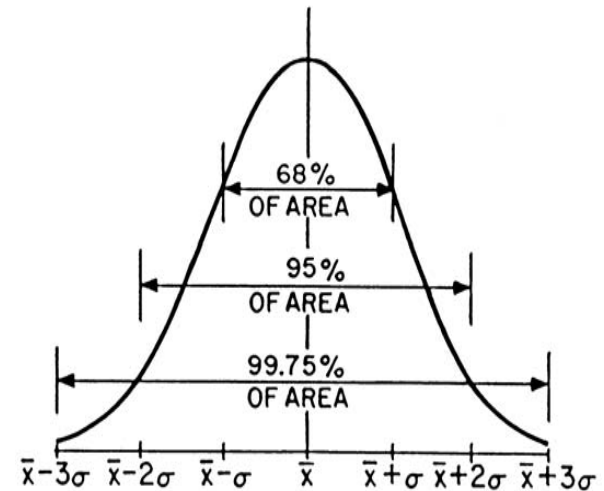


HMA Acceptance

- **Properties**
 - **Binder Content**
 - **Air Voids**
 - **VMA**
 - **Density**

PERCENT WITHIN LIMITS 2006

- **Purpose**
 - **Statistical Specification**
 - **Obtain data on field variability**
 - **Districts familiar with Specification**



Adjustment Period

**3000 t for Surface and 5000 t for
Base and Intermediate Mixtures**

- Gradation -- Within Spec Limits**
- Binder Content -- ± 0.5 %**
- VMA -- Within Spec Limits**

Specification requirements

- **Additional plate samples -- location determined by PE & Producer tested**



Sublot/Lot

- **5 Sublots per Lot**
- **Base and Intermediate -- 1000 t**
- **Surface -- 600 t**
- **First 300 t of Base, Intermediate, and Surface mixture of first subplot of the first lot of each mix design was not sampled.**

Upper Quality Index

$$Q_U = \frac{USL - \bar{x}}{s}$$

Lower Quality Index

$$Q_L = \frac{\bar{X} - LSL}{S}$$

PWL SPECIFICATION LIMITS

Mixture

	LSL		USL	
Air Voids at Ndes, %	2.60		5.40	
Binder Content (Ignition)	- 0.40 from JMF		+ 0.40 from JMF	
VMA at Ndes, %	Greater of		Greater of	
	Spec - 0.50	JMF - 1.20	Spec + 2.00	JMF + 1.20

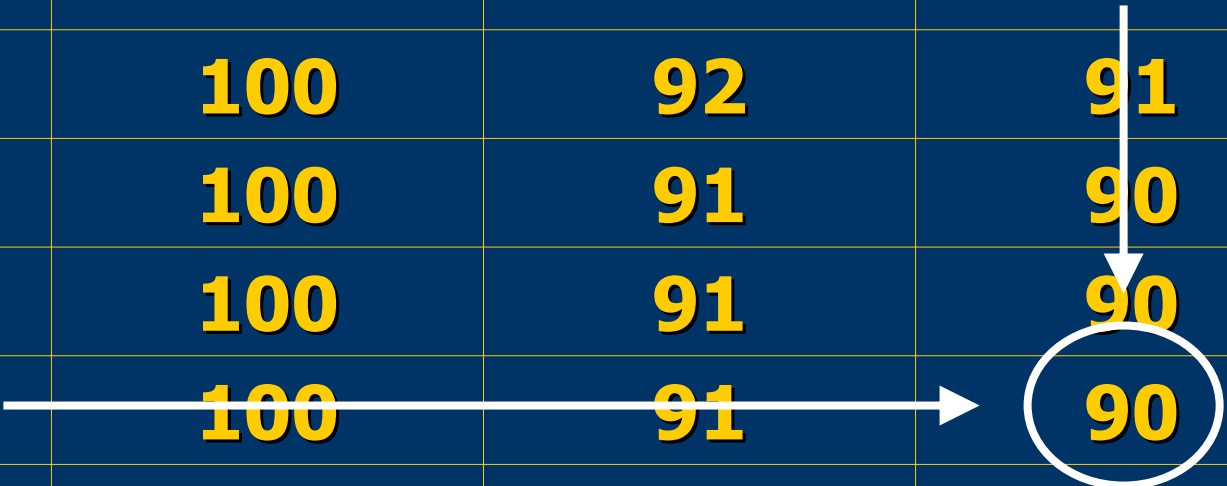
PWL SPECIFICATION LIMITS

Density

	LSL	USL
Core Density (% Gmm)	91.0	Not Applicable

Quality Index (QI) PWL for a Given Sample Size

QI	n = 3	n = 4	n = 5
1.25	100	92	91
1.24	100	91	90
1.23	100	91	90
1.22	100	91	90
1.21	100	90	90
1.20	100	90	89
1.19	100	90	89



Total PWL

$$\text{Total PWL (Binder Content, Air Voids, and VMA)} \\ = (\text{PWL}_U + \text{PWL}_L) - 100$$

$$\text{Total PWL}_{\text{DENSITY}} = \text{PWL}_L$$

Pay Factors

Estimated PWL > 90

$$PF = 105.00 - 0.50 \times (100.00 - PWL)/100$$

Estimated PWL > 42 and ≤ 90

$$PF = 100.00 - 0.000020072 \times (100.00 - PWL)^{3.5877}/100$$

PWL < 42

Failed Materials Committee

Lot Pay Factor

$$\begin{aligned} \text{Lot PF} = & 0.20 (\text{PF}_{\text{binder}}) \\ & + 0.35 (\text{PF}_{\text{voids}}) \\ & + 0.10 (\text{PF}_{\text{VMA}}) \\ & + 0.35 (\text{PF}_{\text{density}}) \end{aligned}$$

Quality Assurance Adjustment

$$q = L \times U \times (\text{Lot PF} - 1.00) / \text{MAF}$$

L = Lot quantity

U = Unit Price

PF = Pay factor

**MAF = Mixture Adjustment
Factor**

Mixtures -- 2006

- **2006 – 8 Contracts**

9.5 mm -- 7

12.5 mm -- 1

19.0 mm -- 2

25.0 mm -- 3

Pooled Standard Deviations

Property	PWL	Specifications
	S	S
Binder Content	0.21	0.20
Air Voids	0.66	0.70
VMA	0.53	0.60
Density	1.37	Min. 91.0 % G_{mm}

PWL -- 2007

- **3 Contracts/District**
- **12.5 mm, 19.0 mm, and 25.0 mm mixtures**
- **Training for INDOT and Contractors -- FHWA**
- **Finalize Specifications for 2008**

HMA Acceptance

- **Laboratory Procedures**
- **Field Procedures – PWL**
- **Sampling & Testing Variables**
- **Quality Control Procedures**

Sampling Procedure



Sample Splitting Procedure



Sample Heating Procedure

- **INDOT – overnight**
- **Producers – immediately to compaction temperature**



Charging the Mold



Extracting Specimens

■ Open Graded

- Specimen extruded 1¼ in. and cooled with a fan for 5 min.
- Specimen extruded 2½ in. and cooled with a fan for 5 min.
- Specimen extruded 3¾ in. and cooled with a fan for 5 min.

■ Dense Graded

- Initially cooled in mold for 10 min. with a fan

Gyratory Compactors Internal Angle

DAV III

- Check all INDOT gyratory compactors during construction season
- Verify Producers when results do not compare with INDOT



Gyratory Molds

- **Internal Diameter (149.90 – 150.00mm)**
- **Checked at INDOT Audit and replaced if not within tolerance**
- **4 of 75 checked in 2006 did not meet**



Bulk Specific Gravity AASHTO T 166

**Audit procedures
of INDOT and
Producers during
construction
season**



Bulk Specific Gravity AASHTO T 166 -- AMRL

1. Suspension wire
2. Towel not Damp
3. Specimen holder not submerged
4. No overflow outlet
5. Temperature of bath not $77.0 \pm 1.8^{\circ}\text{F}$



Maximum Specific Gravity AASHTO T 209

**Audit procedures
of INDOT and
Producers during
construction
season**



Maximum Specific Gravity AASHTO T 209 --AMRL

- 1. Residual Pressure not 25.50 – 30.00 mm Hg**
- 2. Manometer not connected properly**
- 3. Hose opening not covered**
- 4. Not weighed 10 ± 1 min.**



HMA Acceptance

- **Laboratory Procedures**
- **Field Procedures – PWL**
- **Sampling & Testing Variables**
- **Quality Control Procedures**

Quality Control Procedures

- **Asphalt Supplier Certification**
- **Certified Aggregate Producer Program**
- **Certified HMA Producer Program**
- **Quality Control Plans – each contract**
- **Certified Technician Training**

PG Binder Approved Supplier Certification Program

- **Approved Lab – AMRL Inspection and proficiency sample program**
- **Quality Control Plan**
 - **Testing**
 - **Inspection**
 - **Each PG Grade**
- **Monthly summary report of QC tests**

Quality Control -- Binder

- **Sampling Procedure**
- **Storage Requirements from Manufacturer**
- **Method of Changing Grades in Tank**



Binder Acceptance Point - of - Use Sample



Certified Aggregate Producer Program



Gradation

- Start of Production -
- 1/1000t for 5000t
with max of 2/day
- Normal Production -
- 1/2000t
- Load-Out – 1/8000t



Decant

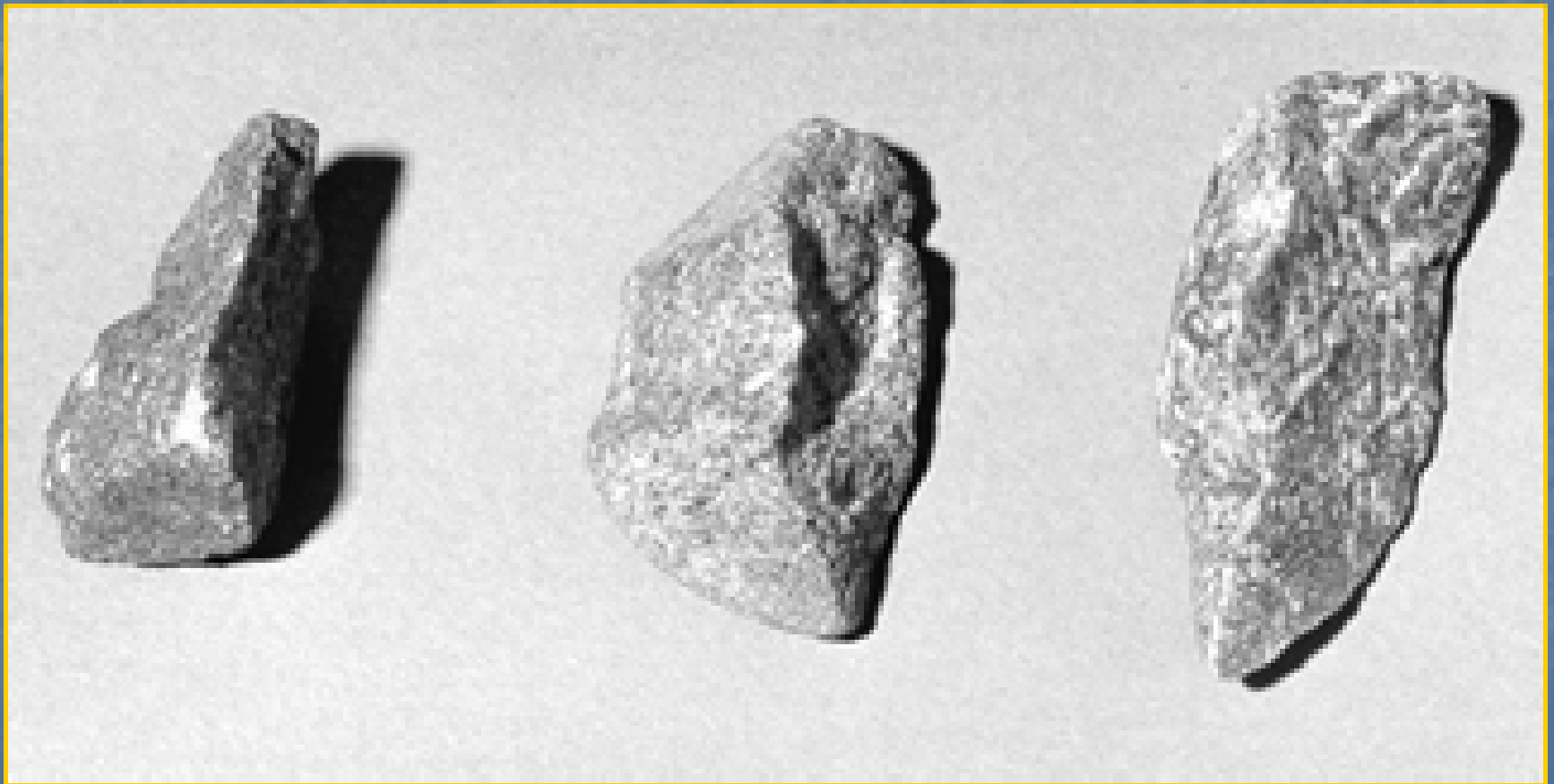
Each load-out sample



Deleterious 1/week for each size



Crushed Content 1/week for each size



Additional Tests

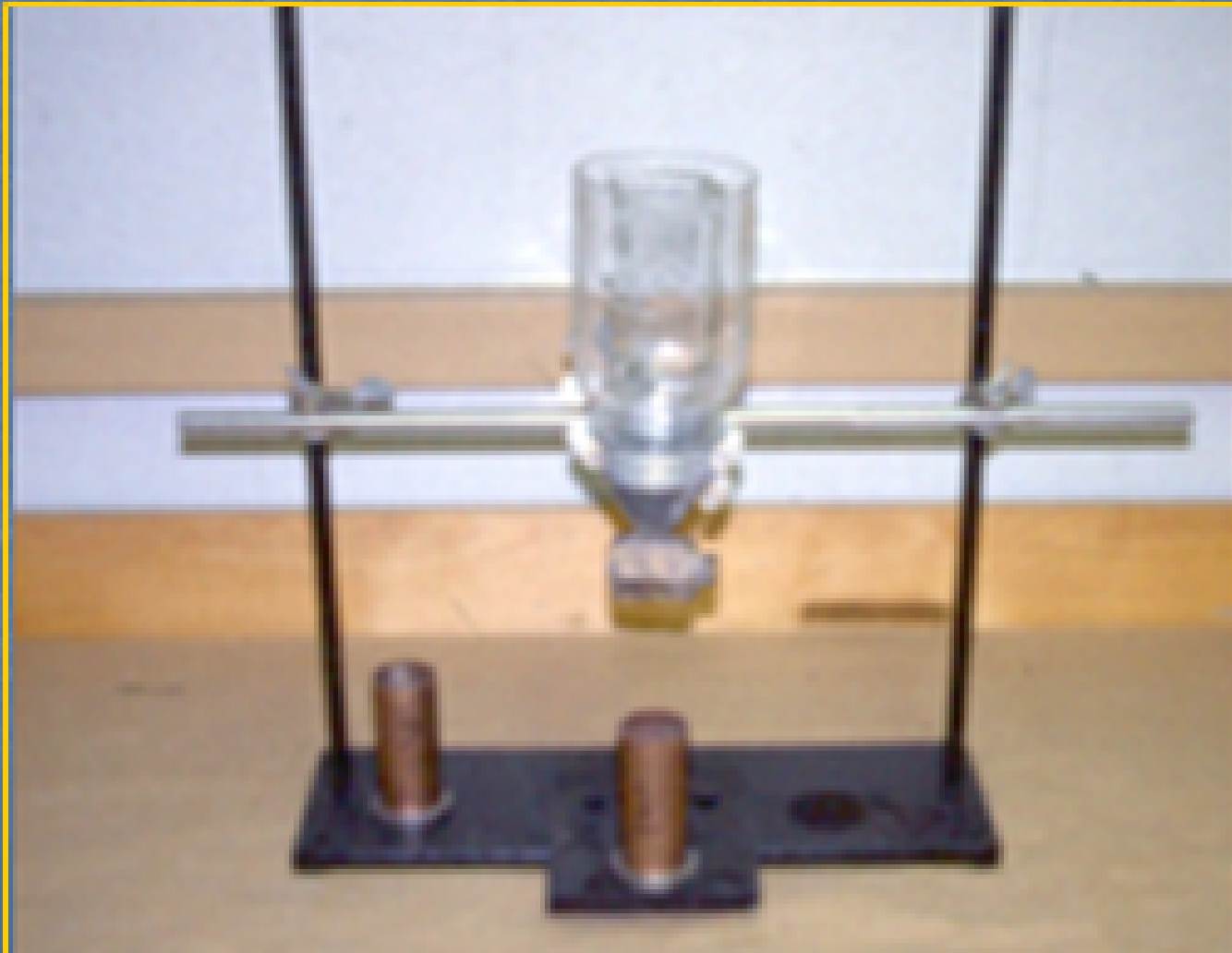
FA Specific Gravity



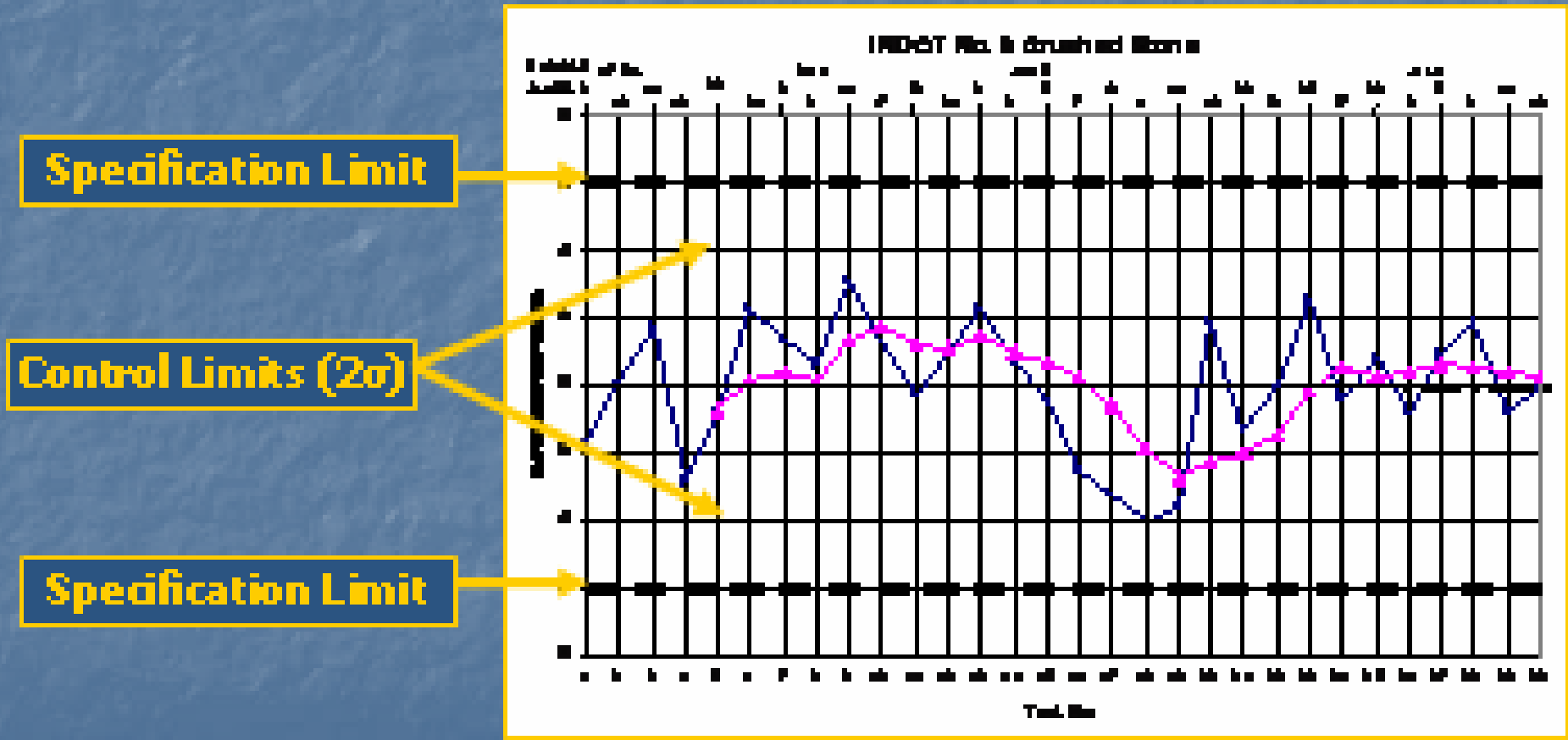
CA Specific Gravity



Additional Tests -- FAA



Control Charts



Quality Control Plans Each Contract

- **Process Balance**
 - **Plant**
 - **Production**
 - **Transportation**
 - **Placement**
 - **Compaction**



Quality Control Plans -Contract

- **Transportation of Mix**
 - **Truck Bed Cover**
 - **Unloading**
 - **Material Transfer Vehicles**



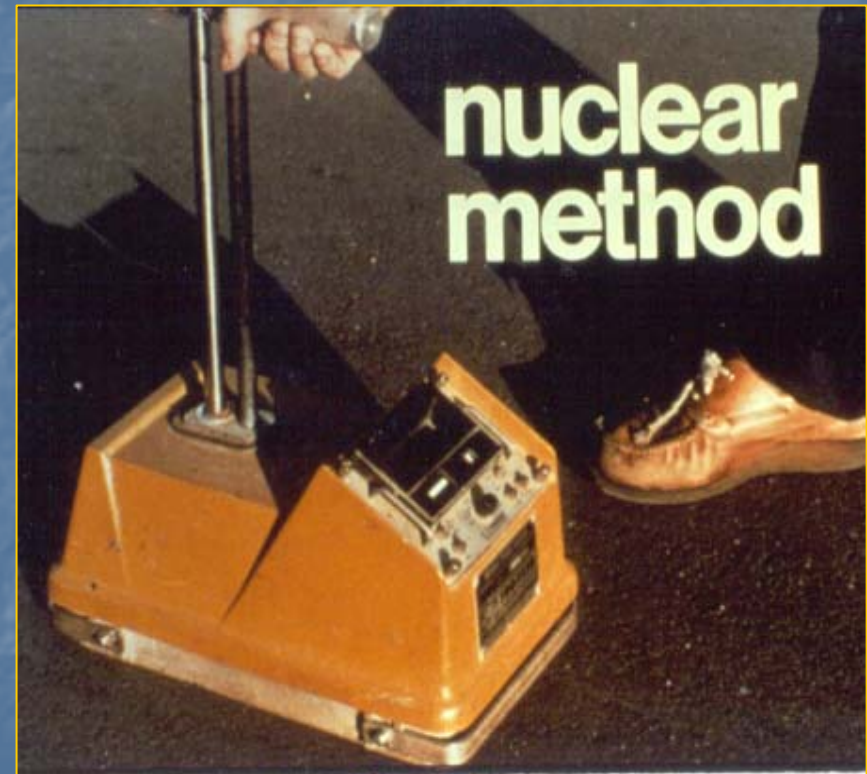
Quality Control Plans -Contract

- **Paving**
 - **Paving Plan**
 - **Material Feed System**
 - **Grade and Slope**
 - **Asphalt Materials**



Quality Control Plans - Contract

- **Sampling and Testing**
 - **Mix**
 - Temperature behind Paver**
 - **Density -- non - destructive**
 - **Smoothness**



Certified HMA Technicians

- **Producers**
 - **INDOT Training and Certification**
 - **Recertification -- 3 years**
 - **Qualified Technician Program**
 - **Proficiencies**
 - **Certified HMA Audit**
 - **Proficiencies**

Certified Technicians

- **INDOT**
 - **Certified Technician Program**
 - **Qualified Technicians -- Proficiencies**
 - **HMA Audits -- Proficiencies**

HMA Acceptance

- **Laboratory Tolerances**
- **Field Tolerances – PWL**
- **Sampling & Testing Variables**
- **Quality Control Procedures**