Mix Troubleshooting Considerations

NEAUPG

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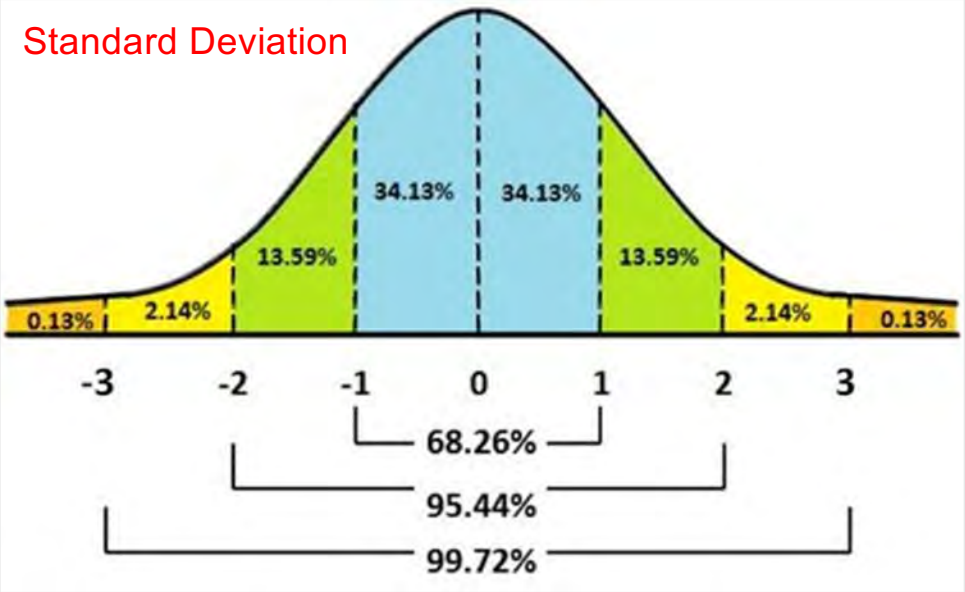
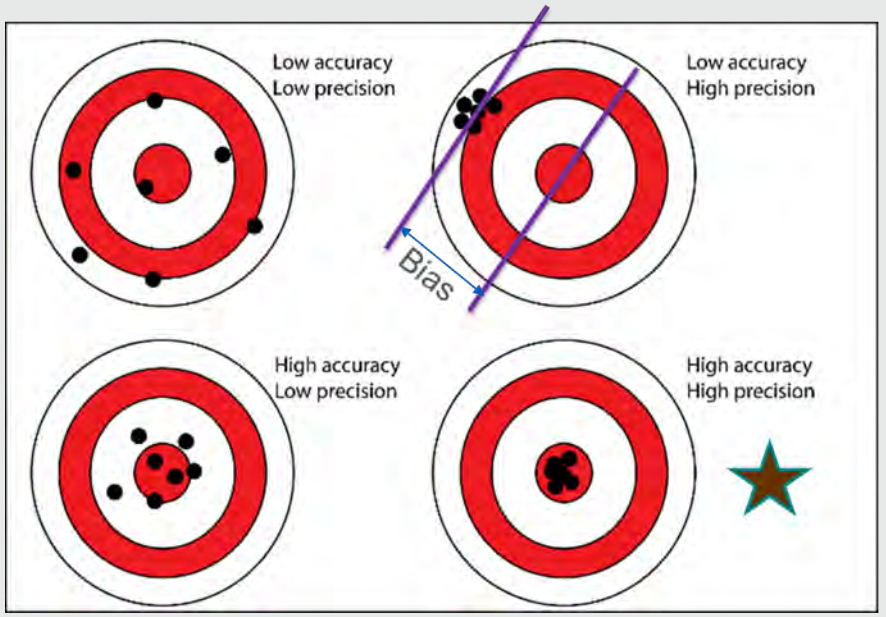
Let’s Get Started…

Discussion Items

- Material Variability
- Troubleshooting Basics
- Production vs JMF – What Could Go Wrong?
- Education and Training
- Effective Communication

Material / Process Variability

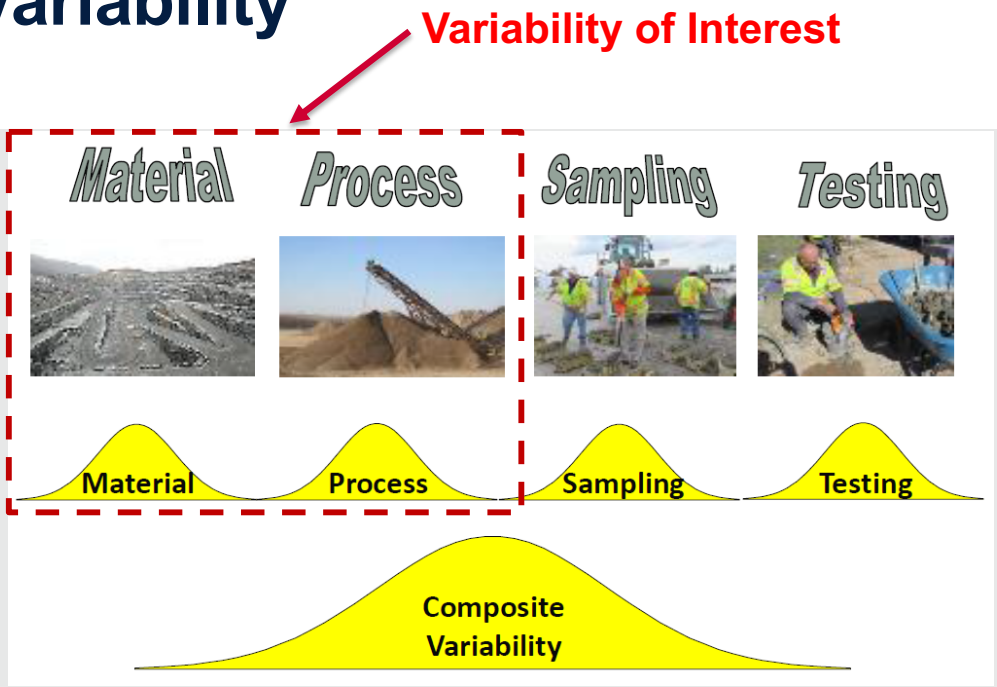




Accuracy and Precision

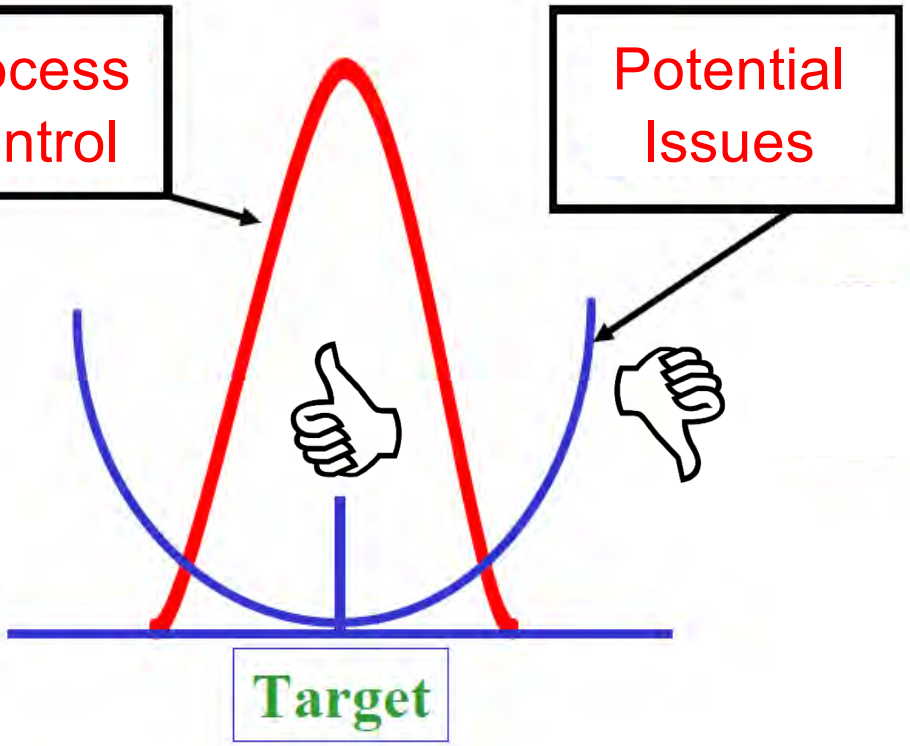
Components of Test Result Variability

- **Material**: True inherent variability lies in the material, which the contractor can't control.
- **Process:** Production and Construction variability.
- **Sampling**: Sample to sample variability attributable to sampling technique variation.
- **Testing**: Operator (new, unskilled, etc.), equipment, calibration, poorly written test procedure



Sampling and testing can account for 50% or more of the test variability!

Hitting the Target with Low Variation is KEY



http://asq.org/statistics/1999/09/statistical-thinking1.pdf

Typical Material Variability Data

Aggregate Blend Grading

Sieve Size	Typical Range for Overall Standard Deviation
19 mm	1.5 to 4.5%
12.5 mm	2.5 to 5.0%
9.5 mm	2.5 to 5.0%
4.75 mm	2.5 to 5.0%
2.36 mm	2.5 to 4.0%
1.18 mm	2.5 to 4.0%
0.60 mm	2.0 to 3.5%
0.30 mm	1.0 to 2.0%
0.15 mm	1.0 to 2.0%
0.075 mm	0.6 to 1.0%

Source: NCHRP Report 673 Manual for the Design of HMA

Mix Volumetrics

Property	Typical Range of Value for Overall Standard Deviation
Asphalt content	0.15 to 0.30%
Air void content, from field cores	1.3 to 1.5%
Laboratory air void content	0.9%
VMA	0.9%
VFA	4.0%

- ***Lower values indicate a more controlled operation and an easier job for the QC personnel!***
- ***As a producer, you MUST know these variabilities for YOUR mixes!***
- ***As an owner, these variabilities should be considered when establishing specifications.***

You MUST Know Your Materials/Process Variability

- Designing and producing an asphalt mix without knowing associated materials and process variability is a disaster in the making.
- Local experience is the most valuable and needed item available.
  1. Know your materials
  2. Know your equipment
  3. Know your people

Prioritization Matrix for Variability

1. Understand all potential causes of variability
2. Prioritize them based on impact (value provided) and ability to control (effort required).

https://www.nngroup.com/articles/prioritization-matrices/

Basic Troubleshooting Tips

Idaho Materials and Construction, Hwy 55

Pike Industries, I295

What is Troubleshooting?

- **Troubleshooting** involves the evaluation AND adjustment of a process to correct the problem.

trou·ble·shoot
/ˈtrəbəlˌSHo͞ot/

verb
gerund or present participle: **troubleshooting**

solve serious problems for a company or other organization.
- trace and correct faults in a mechanical or electronic system.

- **Evaluation** is reviewing the data and taking action.

e·val·u·ate
/əˈvalyəˌwāt/

verb

form an idea of the amount, number, or value of; assess.

- **Adjustments** are meant to be small changes, not a complete mix over haul.

ad·just
/əˈjəst/

verb

1. alter or move (something) slightly in order to achieve the desired fit, appearance, or result.

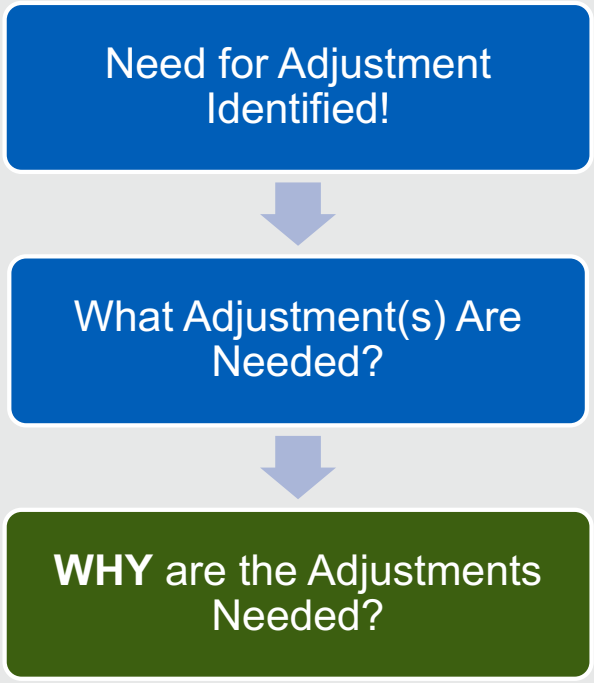
Adjustment Tips

- Avoid having multiple people making adjustments.
  - Define the responsible party
- Make only one adjustment at a time.
  - Multiple adjustments can make cause and effect impossible.
  - Can prolong or exacerbate the problem.
- Product sufficient mix after adjustment to make accurate determination on the adjustment impact.
  - Let the plant adjust to the adjustment (50 to 100 tons minimum)
- Maintain adjustment diary or log.
  - Don't …1) make same mistake twice and 2) forget what worked!

Remember the WHY!

- Steps in adjustment
  1. Identify a need.
  2. Determine what adjustment is needed.
  3. Remember the Why?

For example, lowering the P200 by cutting the screenings may help raise air voids, BUT what is the real reason for the P200 increase?



Air Voids Troubleshooting

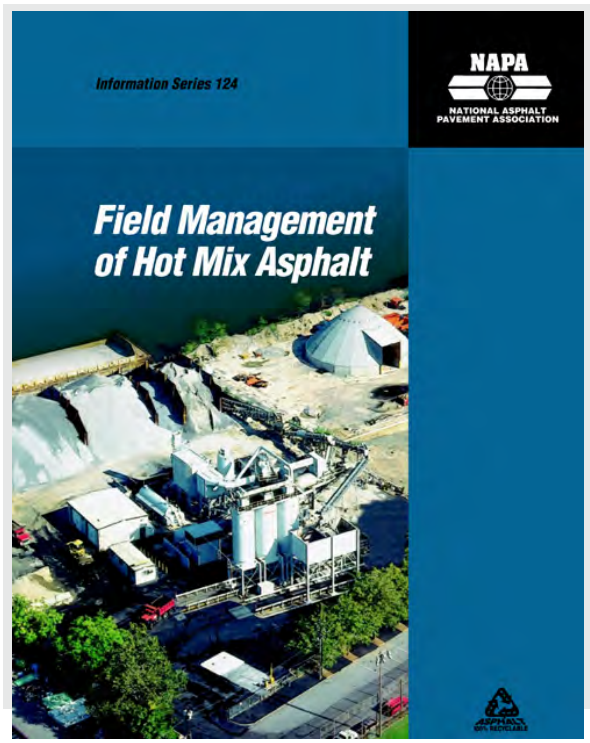
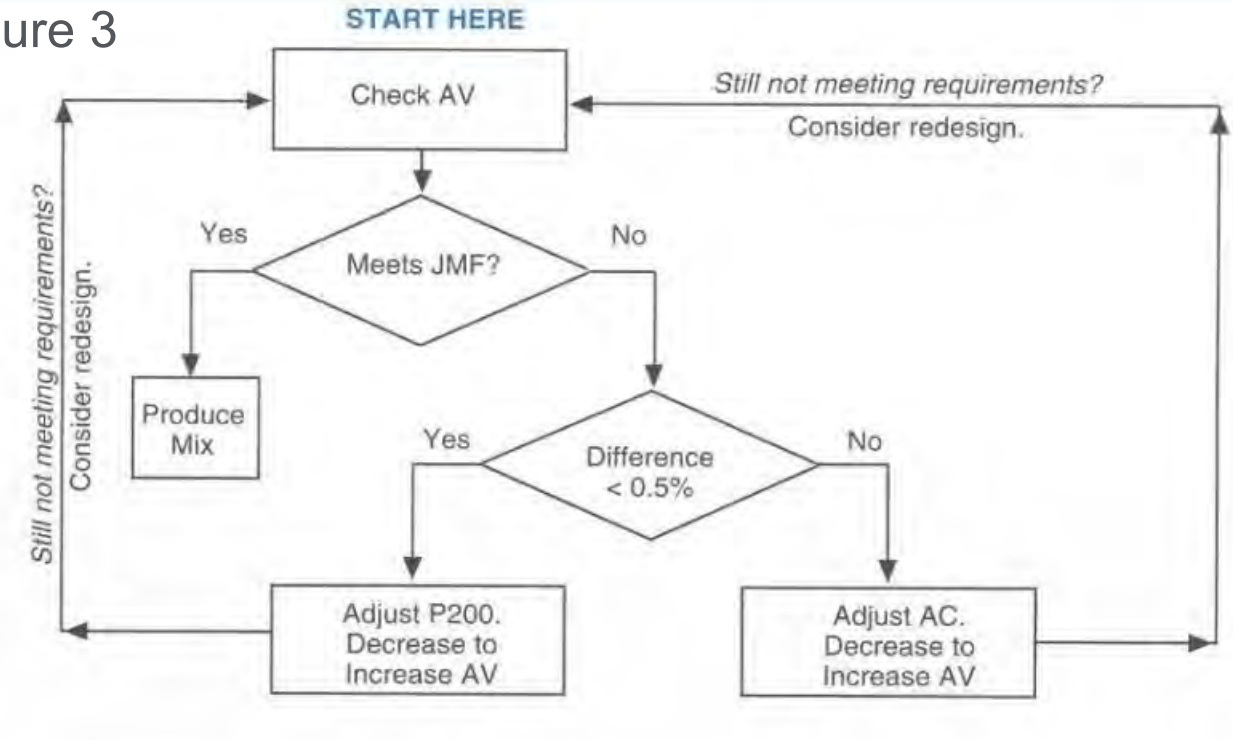


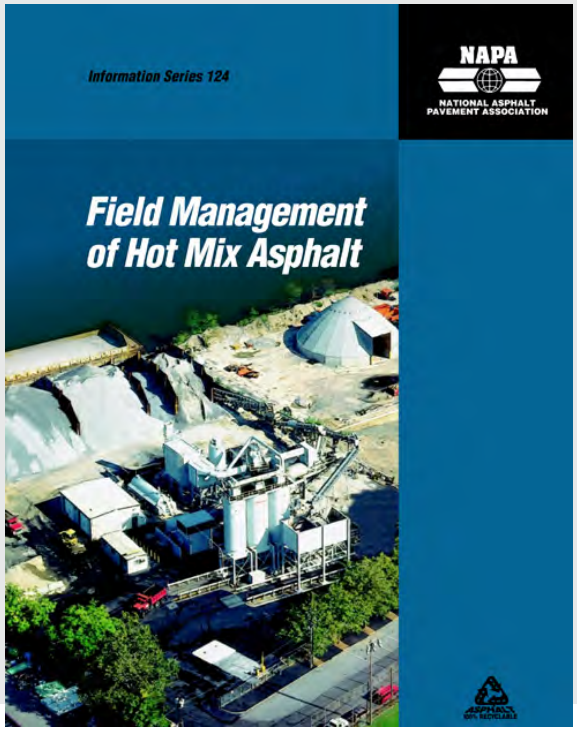
Figure 3



VMA = Voids in Mineral Aggregate
AV = Air Voids
P200 = Percent passing 0.075 mm (#200) sieve

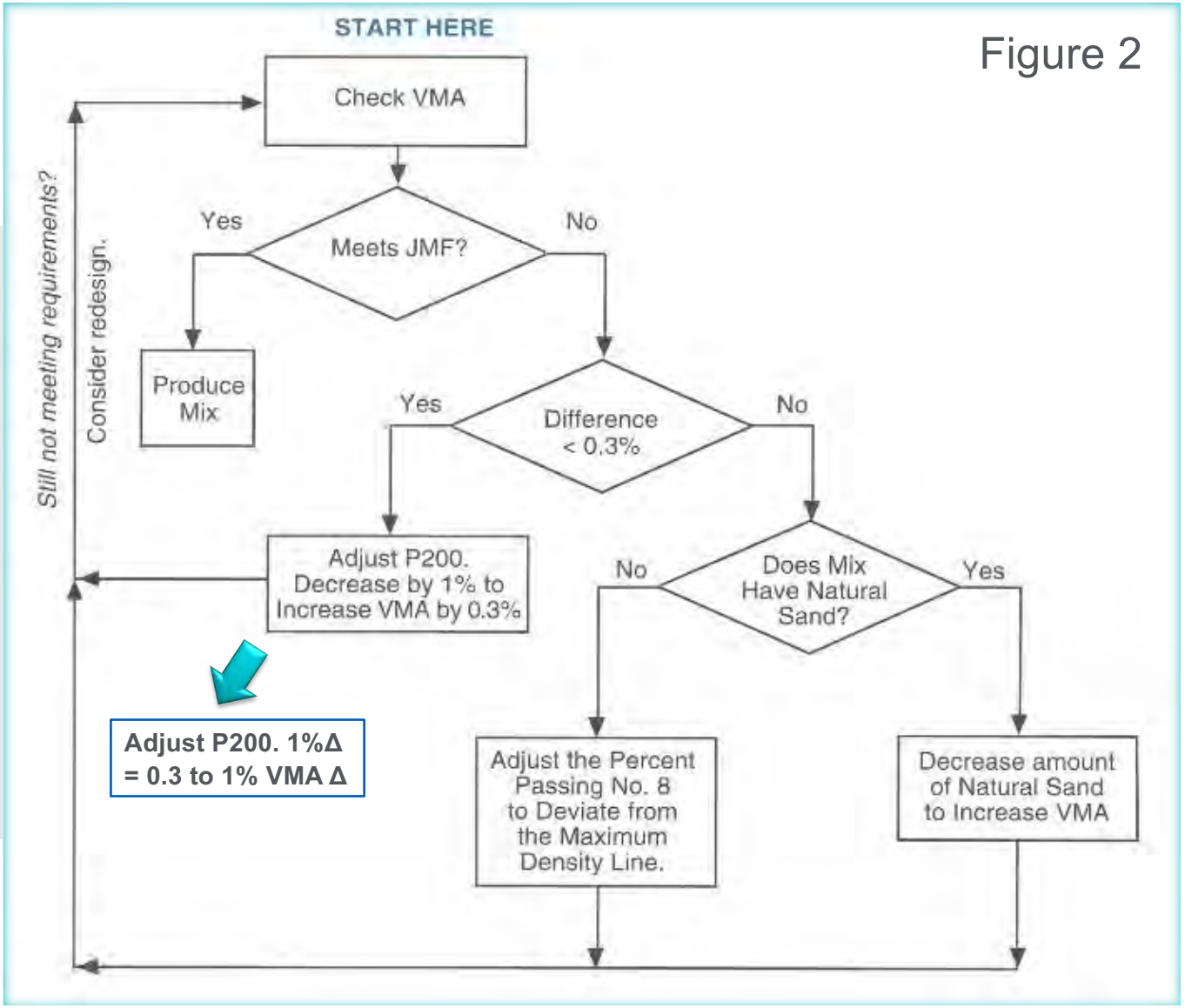
NOTE: This flow chart is intended to provide guidance for adjustment of AV. Due to differences in properties of specific mixes, the effect of the adjustments may be variable.

VMA Troubleshooting



http://store.asphaltpavement.org/index.php?productID=754

Figure 2



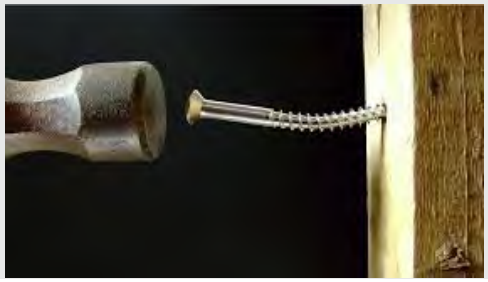
General Rules of Thumb

- Develop a master "IF/THEN" chart for **YOUR** mixes.
- Valuable resource if developed correctly!

IF				THEN		NOTES
Gmm	↑			Asphalt Binder	↓	0.015 to 0.020 change for 0.5% binder
Gmm	↓			Asphalt Binder	↑	
Gmb	↑			Asphalt Binder	↓	
Gmb	↓			Asphalt Binder	↑	
P200	↑			Air Voids/VMA	↓	1.0% Δ P200 = 0.3% to 1% Δ VMA
Asphalt Binder	↑			Air Voids	↓	0.1% Δ AC = 0.25% Δ Air Voids
Asphalt Binder	↔	Air Voids	↓ ↑	VMA	↓ ↑	Vbe = VMA - Va
Asphalt Binder	↔	No. 8 x No 200	↓	Air Voids	↓	Fine graded mixes
Asphalt Binder	↔	No. 8 x No 200	↑	Air Voids	↑	Fine graded mixes
Gmb	↓	Asphalt Binder	↔	P200	↓	
Gmb	↑	Asphalt Binder	↔	P200	↑	

Prior to Making an Adjustment, Ensure the Following

1. Mix design is correct.
2. Mix design is correctly input into the plant.
3. Plant components are properly calibrated.
4. Lab equipment is properly calibrated.
5. Personnel are properly educated / certified.
6. Personnel roles and responsibilities are assigned.
7. Sample is random and representative.
8. Sample is processed correctly (e.g., split).
9. Proper test procedures are being utilized.
10. Results are double checked.



Main Level Focus Areas

Main Focus Areas

1. Aggregate
2. Recycle
3. Binder
4. Plant

- The key to quality control is to accurately determine the cause of the current difference and minimize the frequency and magnitude of future occurrences.

Main Aggregate Focus Areas

1. Stockpile moisture excessive / variable
2. Gravities different / variable from design
3. Segregation (stockpiling and loadout)

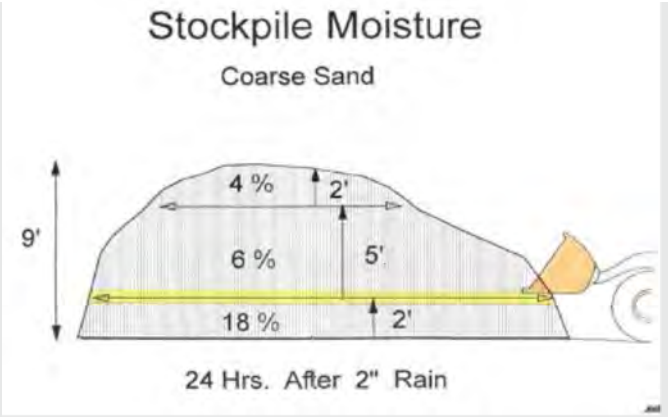
Stockpile Moisture

- Water quantities falling on a stockpile during a rain event is very significant.
- Example: 100 ft. x 100 ft. stockpile will collect 26 tons of water after a 1” rainfall event.

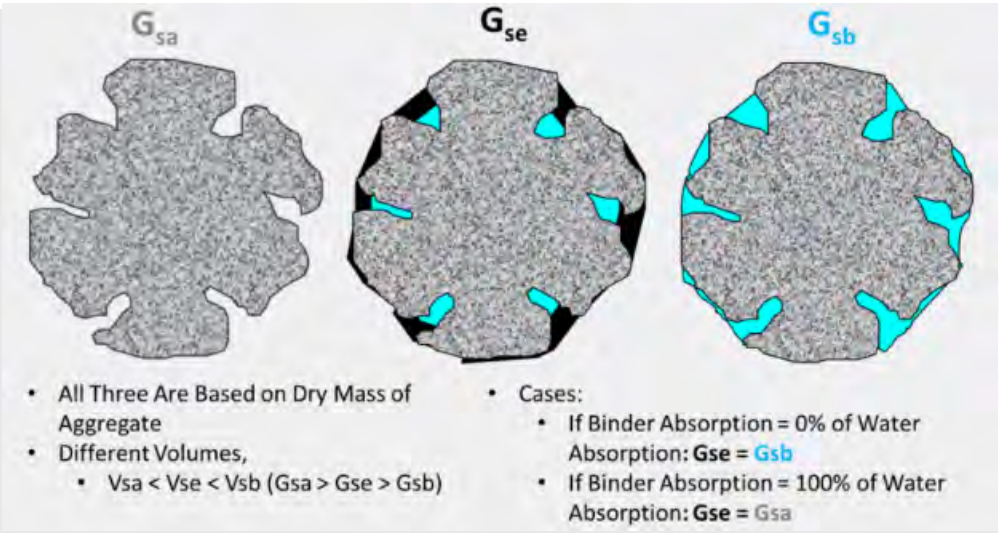
Stockpile Footprint (sf)	Approximate Dimensions, ft	Water Tonnage Over Footprint After Given Rainfall Events (in)			
		0.5	1	2	3
5000	70 x 70	7	13	26	39
10000	100 x 100	13	26	52	78
15000	125 x 125	20	39	78	117
20000	140 x 140	26	52	104	156
25000	160 x 160	33	65	130	195
30000	175 x 175	39	78	156	234

Stockpile Moisture

- Water retention is maximized with well graded fine aggregate with high minus 200 content (i.e., screenings)
- Fine aggregate, RAP and RAS stockpiles are very prone to holding moisture
- Cover and pave under + slope stockpiles to minimize moisture.
- Rule of Thumb: 1% increase in moisture…
  - Decreases plant production by 11%
  - Increases energy consumption by 11%
- **Uncontrolled moisture = uncontrolled volumetrics!**

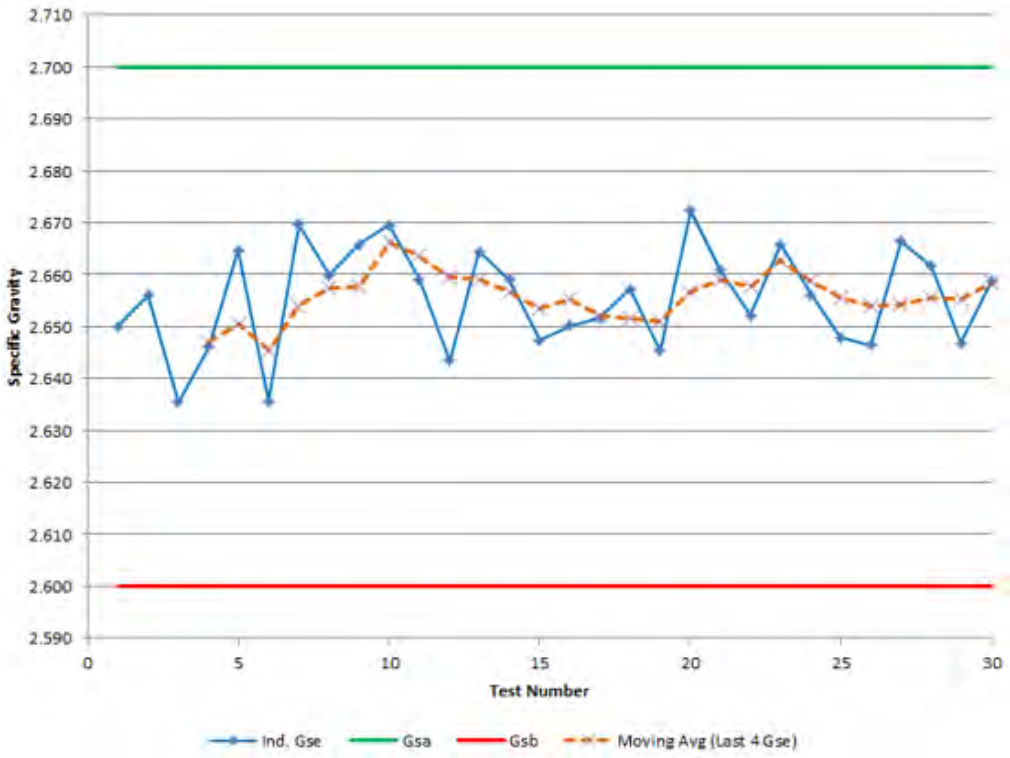


Aggregate Specific Gravity Relationships



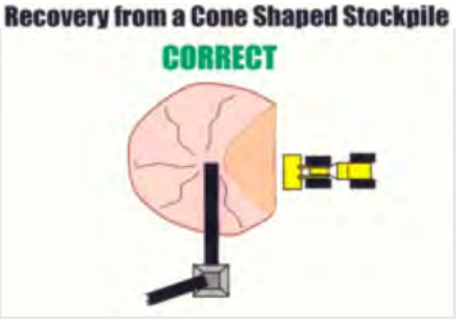
G_{se} is an aggregate property. For a given mix design, the relationship between G_{se} to G_{sa} and G_{sb} should not change (within test variability)

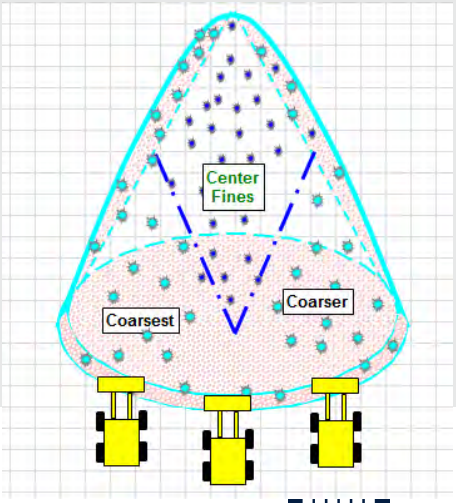
No. 1 Item to Monitor During Production



Segregation

- MUST prevent segregation of material when stockpiling and loadout!





Main Recycle Focus Areas

- Consistent supply
- Binder content accuracy

Incorrect or Inconsistent Aggregate / Recycle Supply

- Incorrectly calibrated cold feed bin feed or weigh bridge can result in substantial errors.
  - Recycle feed issues will double issues: grading and binder content.
- Properly calibration procedures must be utilized on a routine basis.

Incorrect Recycled Materials Binder Content

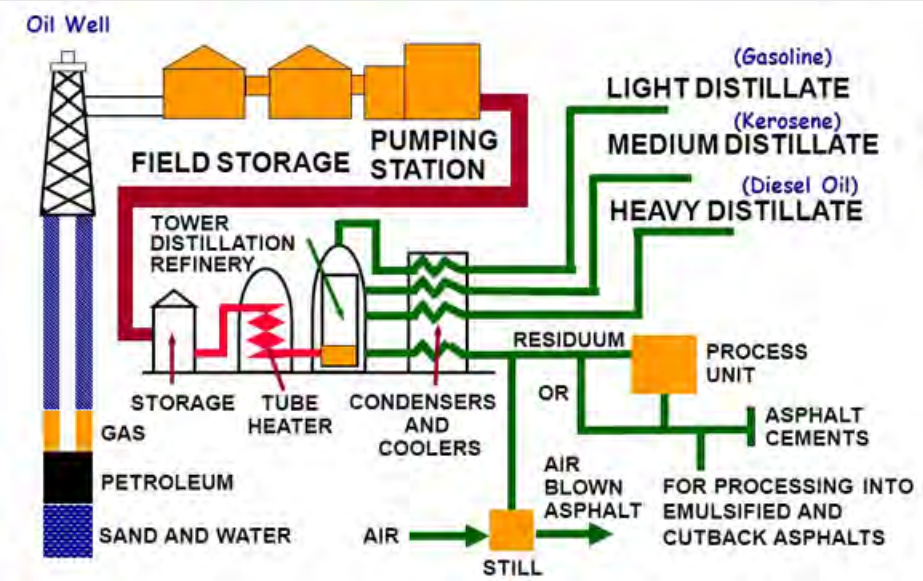
- Accurate binder content is required for the recycled products.
- Design value must be the “true” stockpile value!
  - Assume 30% RAP in a mix
  - Design RAP binder content used = 5.0%
  - Binder from RAP = 0.30 (5.0) = 1.5%
  - Actual Stockpile RAP = 4.5%
  - Error in virgin binder addition = (4.5 – 5.0) x 0.30 = - 0.15% (too little binder added, dry mix issues)
- Proper recycled stockpile process control is a MUST!

Main Asphalt Binder Focus Areas

- Binder different than design (even though using the “same” PG)
- Variable binder addition

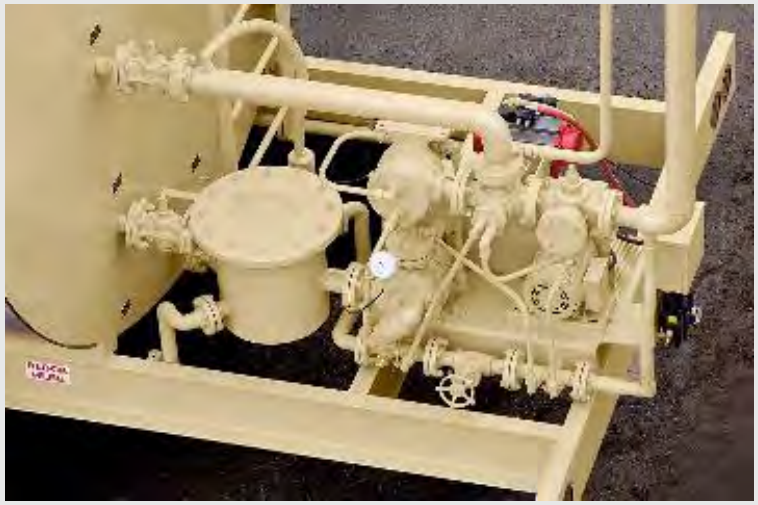
Binder Differs From Design

- Crude sources used for binder manufacture are constantly changing.
- Two binders with the same PG classification can act differently.
- Should obtain / monitor the true PG classification from the binder manufacturer to help ensure consistent source from production relative to design.



Variable Binder Addition

- Asphalt binder addition errors can be caused by a multitude of reasons.
  - Plant operator error
  - Incorrect asphalt pump operation / calibration
  - Weighing issues on conveyor
  - Incorrect adjustment for aggregate moisture



Variable Binder Addition

- The plant moisture setting should match the actual moisture content of the aggregate/recycle blend.
- **Case 1: Actual moisture > Plant moisture**
  - **Plant thinks the difference is aggregate and adds too much binder**
- **Case 2: Actual moisture < Plant moisture**
  - **Plant thinks the difference is moisture and adds too little binder**
- Too little or too much binder will result in volumetric property, compaction, and cost issues!

YTD Moisture Effect On Binder

Input	Division	
	Company	
	Plant	
	Plant Name	
	Combined Moisture Setting	2.0%
	Combined Actual Moisture	3.0%
Plant Performance Data	Average Cost of Binder	$486.86
	Sold Tons	103,809
	Average Virgin Binder %	4.1%
Calculated	Difference in Moisture	1.0%
	Difference in Binder %	**0.04%**
	Actual Binder %	4.16%
	Extra Cost of Binder per Ton Sold	**$0.20**
	Extra Cost for Sold Tons	**$20,805**

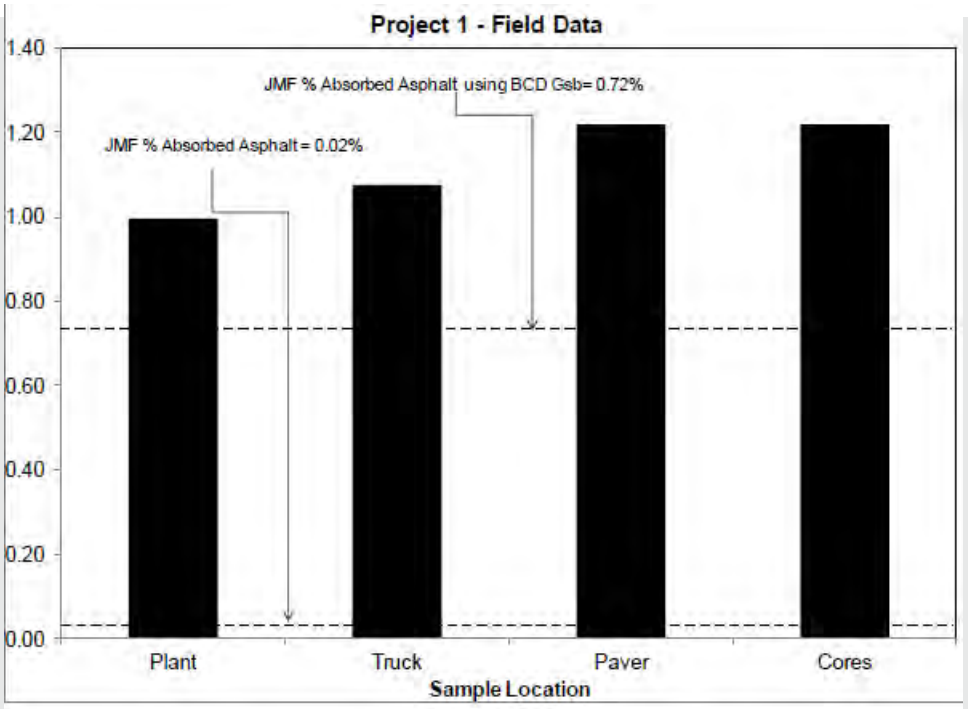
Main Plant Focus Areas

- Excessive mix switchovers
- Inconsistent temperature / storage time

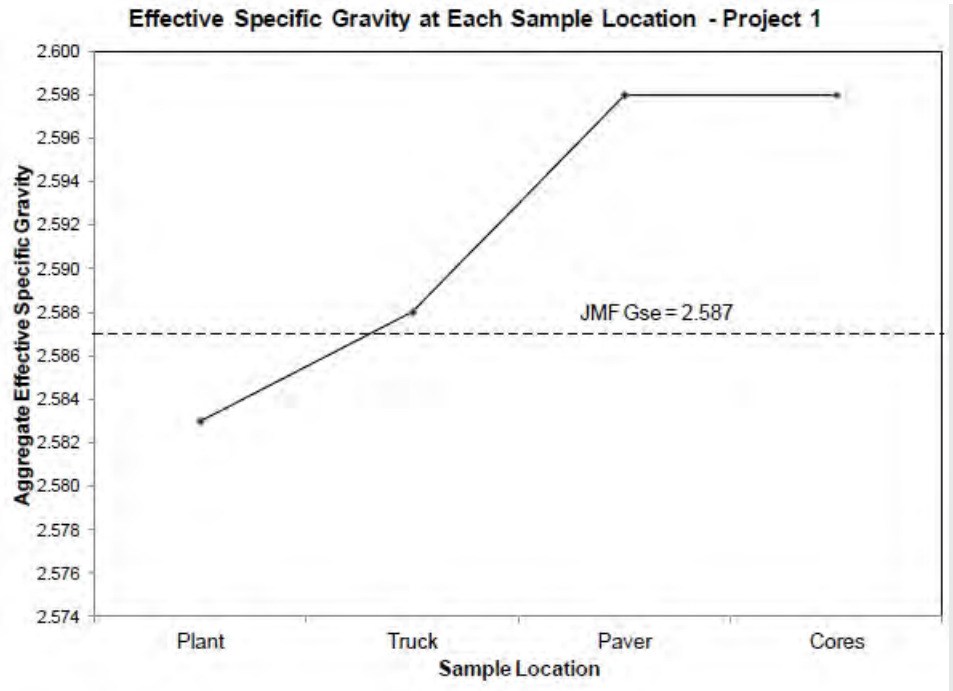
Excessive Mix Switchovers

- Production of a single mix for the entire day highly desirable, but unrealistic, for consistency considerations.
- Concern with continuous mix (drum) facilities where the mix is changed “on the fly”.
- Tips
  1. Maximize production runs of a particular mix.
  2. Minimize / consolidate the number of mixes produced in a particular plant. Especially critical for high profile mixes with stringent acceptance requirements/specifications (e.g., interstate SMA project).
  3. Don’t treat all plants as a “grocery store”, “cafeteria”, “buffet”, or “vending machine”.
  4. Communicate with customers to let them know about similar mixes.

Mix Storage Impact on Absorbed Binder + Gse



Binder Absorption, Pba



Effective Specific Gravity, Gse

http://mdot.ms.gov/documents/research/Reports/Interim%20and%20Final%20Reports/State%20Study%20245%20Aggregate%20Absorption%20in%20HMA%20Mixtures.pdf

Properly Educated / Trained Personnel

Education vs Training

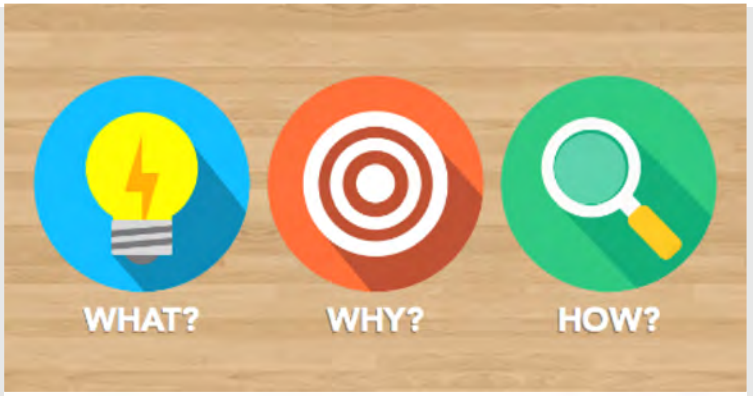
Education ≠ Training

- Education is a concept based, long term, wider scope learning system.
- Training is focused on learning or gaining a particular skill.

- Both are critical for a successful project.
- Must be 1) educated to understand the total picture concept of a project, but 2) trained well enough to accomplish specific tasks.

Training Importance

- Proper training help ensure personnel perform task in a correct, repeatable manner.
- People should be taught to truly understand the what, why and how during training and not just generic procedures.
  - What's happening?
  - Why is it happening?
  - How can I stop it from / keep it happening?



"Effective" Communication

What is Effective Communication?

- Communication is a process of transferring information from one entity to another.

- **Effective Communication** is a process where a message is received and understood by the receiver in the manner that the sender intended it to be.

http://www.people-communicating.com/what-is-communication.html

Three Key Activities of Effective Communication

- Speaking
  - Clear and concise
- **Listening**
  - **Active process requiring your full attention and concentration**
- Feedback
  - Confirms an understanding of the sender's message

Best tool for communication is a good set of ears!

Summary…

1. Understand **WHY** the adjustment is needed, not just that it is needed.
2. Develop local experience to drive correct adjustments for your mixes.
3. Known your variability components and take action to limit variability.
4. Focus on the main level areas that can make production different from the JMF.
5. Acknowledge that Education and Training are not equal. Train personnel for task specific areas to limit variability.
6. Effectively communicate between design/production/construction.
7. **ENJOY YOUR JOB, BE THANKFUL!**

R E C A P

Thank you