



# Obtaining Quality In a Variable Operation

**Dale S. Decker**  
**Eagle, Colorado**



# Two Puzzle Pieces Today

- **Plant Operations**
- **Lab Testing**



# Plant Operations



# Mix Design Assumptions

- **Plant can duplicate lab design**
- **If plant gradation & asphalt content match JMF, mix properties will be same as lab design**

# Mix Design Assumptions

*Unfortunately,*

These assumptions  
are ***NOT*** normally  
true!!!



**Don't assume lab mix  
properties can be  
duplicated in HMA plant.**

***Mix verification through  
plant critical.***

# **Plant Inspection Issues**

- **Verify Calibration of bin feed and asphalt weigh system**
- **Verify temperatures constantly**
- **Ensure uniformity of mix**



# Troubleshooting Gradation

# Troubleshooting Gradation

- **Compare gradations**
  - **Extracted**
  - **Combined aggregates**
  - **Individual aggregate**



# **Troubleshooting Gradation**

## **Extracted Gradation**

- **Sample from**
  - **Truck**
  - **Windrow**
  - **Roadway**
- **Check against design targets**
- **Additional sampling if unmatched**

# **Troubleshooting Gradation**

## **Combined Aggregate Gradation**




- **Aggregate conveyor**
- **Automatic sampler**
  - **Verify against belt cuts**
- **Hot stop belt cut**

# Troubleshooting Gradation




## Individual Aggregate Gradation

- **Sample leaving cold feed bins**
- **Container under feeder**
- **Hot stopped**
- **Loader buckets extracted from feeding face of stockpile**
  - **“Mini” stockpile**



# Drum Mix – Plus P200

Gradation	OK?	Investigate
Extracted		<ul style="list-style-type: none"><li>• Gradation change of individual material</li><li>• Stockpile segregation</li></ul>
Combined		
Individual		

# Drum Mix – Plus P200




Gradation	OK?	Investigate
Extracted		<ul style="list-style-type: none"><li>•Feed bin out of calibration</li><li>•Plugged feed bin</li><li>•Wrong mix design</li></ul>
Combined		
Individual		

# Drum Mix – Plus P200




Gradation	OK?	Investigate
Extracted		•Mix Segregation
Combined		
Individual		






# Drum Mix – Minus P200

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Combined		
Individual		

# Drum Mix – Minus P200

Gradation	OK?	Investigate
Extracted		<ul style="list-style-type: none"><li>•Production rate changes w/100% BHF</li></ul>
Combined		<ul style="list-style-type: none"><li>•Draft with partial BHF</li><li>•Uncalibrated BHF return if partial</li></ul>
Individual		<ul style="list-style-type: none"><li>•Inclined dust screw w/start &amp; stop</li><li>•Mix segregation</li></ul>

# Troubleshooting Asphalt Content Problems

- **Drum**
- **Batch**



# **Inconsistent Binder Content Error**

- **Segregation of mix**
- **Asphalt flow control**
  - **Belt scales**
  - **Asphalt meter**



# Troubleshooting Asphalt Content Problems

## *Drum*

- **Automation determines asphalt flow**
- **Belt scales must be calibrated**
- **Asphalt meter must be calibrated**
  - **Calibrations should be done over different speed ranges**

# **Factors Affecting Asphalt Content Accuracy**

## ***Continued***

- **Climatic conditions**
  - **Extreme temperature swings**
  - **Will scale maintain “zero”**
- **Aggregate Moistures**
- **Ignition oven effect of moisture**



# **Factors Affecting Asphalt Content Accuracy**

## ***Continued***

- **Asphalts of different suppliers may have different meter calibration factors**
- **Account for binder in RAP/RAS**
- **Segregation of mix at plant**
- **BHF effect on binder/gradation/asphalt content in mix**

# **Consistent Binder Content Error**

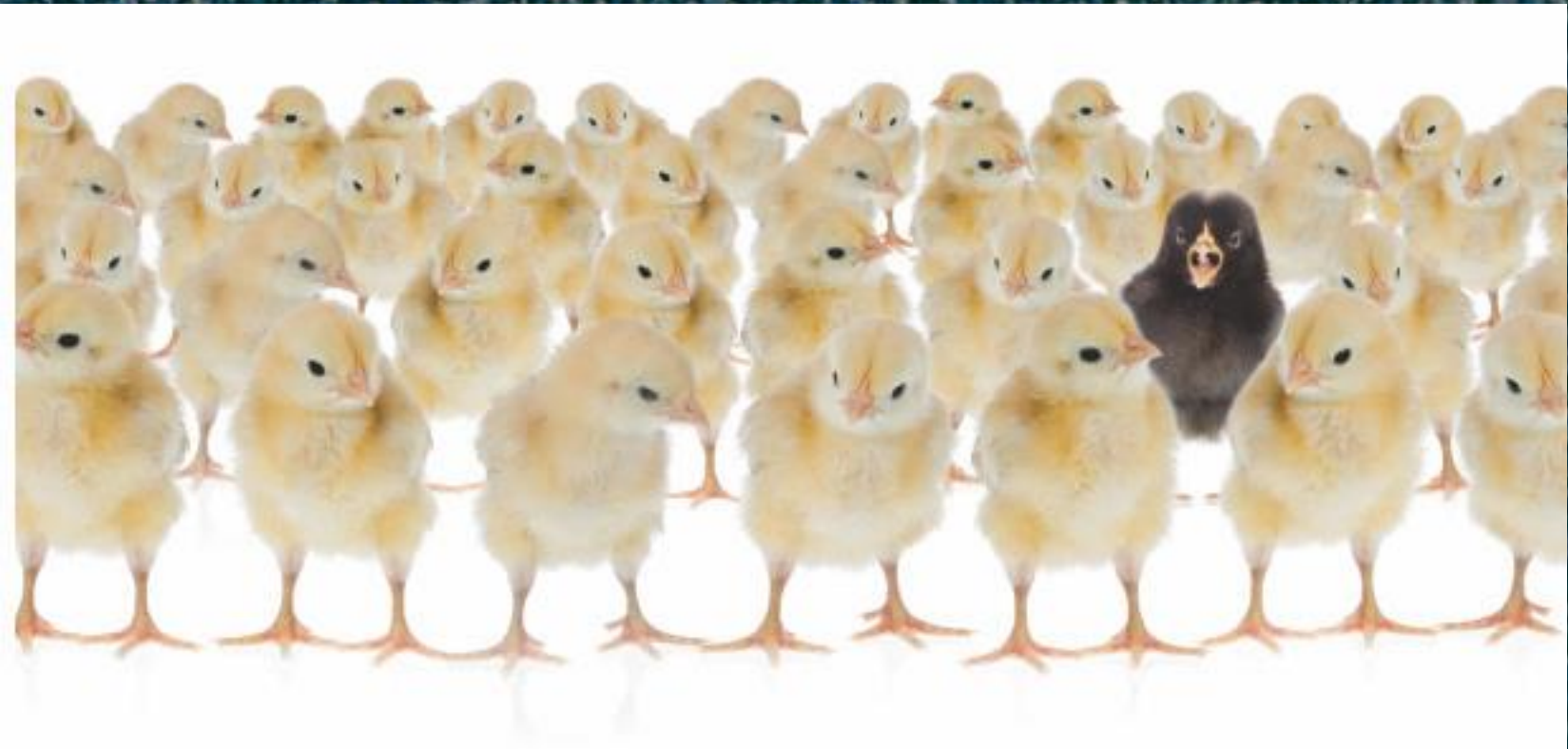
- **Possible calibration error**
- **Improper data input**
  - **Meter calibration factor**
  - **Specific gravity of binder**
  - **Asphalt content of RAP/RAS**

# Lab Testing



# Lab Testing

- **Variability**
- **Test Procedures**
- **Inspection Issues**



# ***Some background...***



**The biggest source of  
variability!**

APR 18 2005

# Understanding Variability

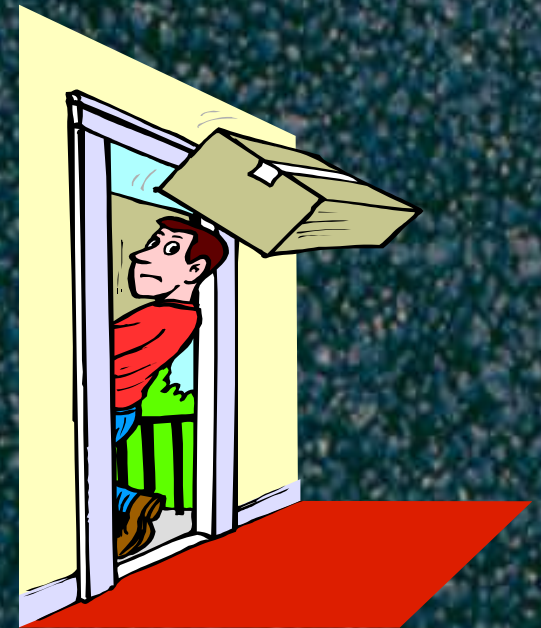
Statistics as a Tool

# **Test Method Variability**

- **Is test method precise?**
- **Which of several methods is most precise?**
- **What is quality of lab work?**
- **Has material become contaminated?**
- **What are appropriate manufacturing targets?**

# Variability Example

- **Average adult male in U.S. is 5'9"**
- **Info not very helpful to determine how tall to make doorways**

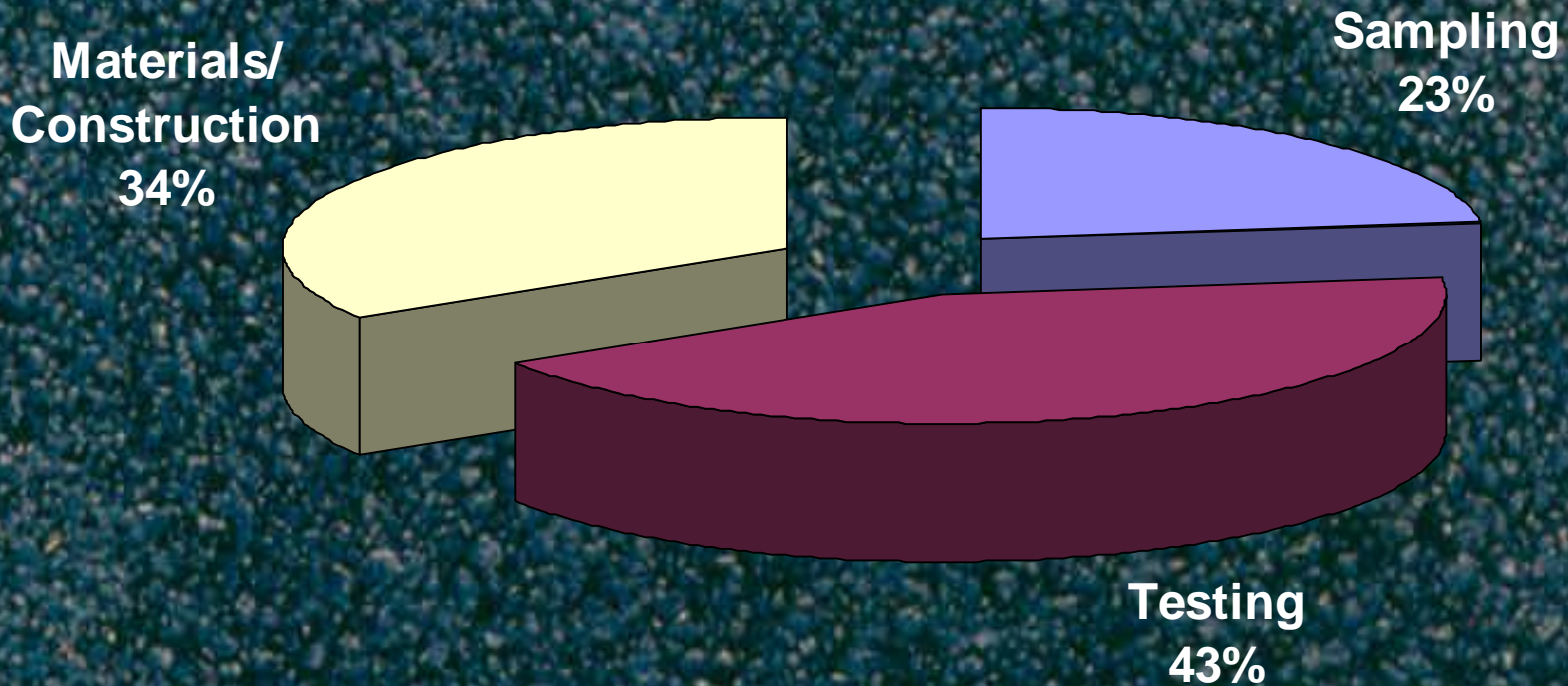




# Sources of Variability

- **Within Lab**
  - **Comparison of test results for same tech in same lab performing test at different times**
- **Between Lab**
  - **Comparison of test results for two techs in different labs**

# Variability



# Examples of Variability

- **Aggregate sampled consistently from one side of a stockpile**
  - **Gradation may be influenced by wind blown particles**
- **Mix consistently sampled from edge of paved lane**
  - **Segregation can influence test methods**

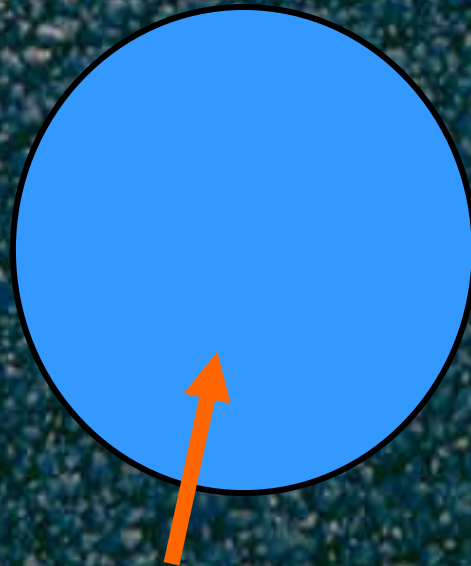
# Test Variation

When result outside range

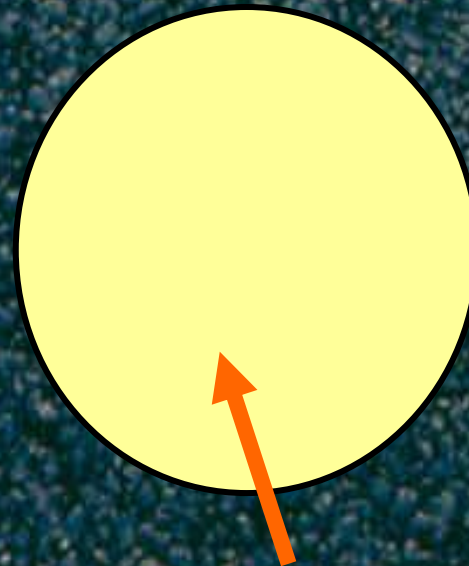
**Re-evaluate test results  
before applying any penalty**



# Independent Variables



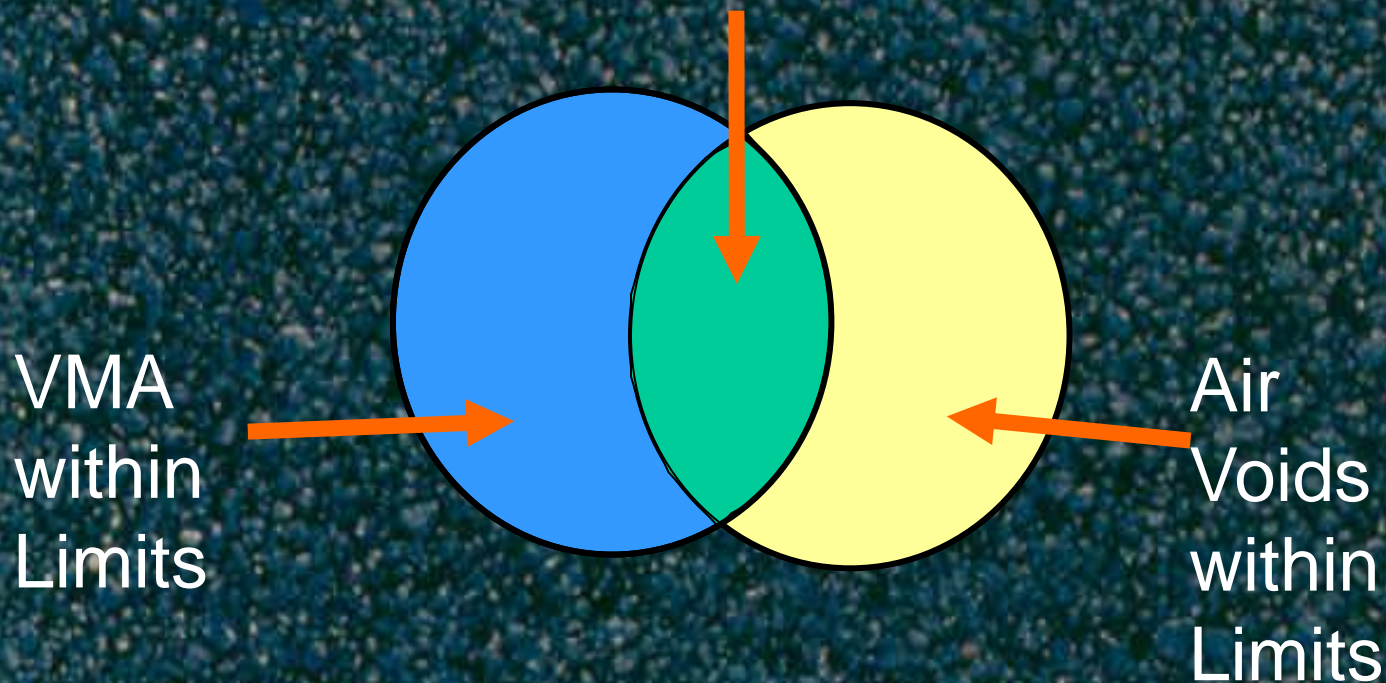
Layer  
Thickness  
in Specified  
Limits



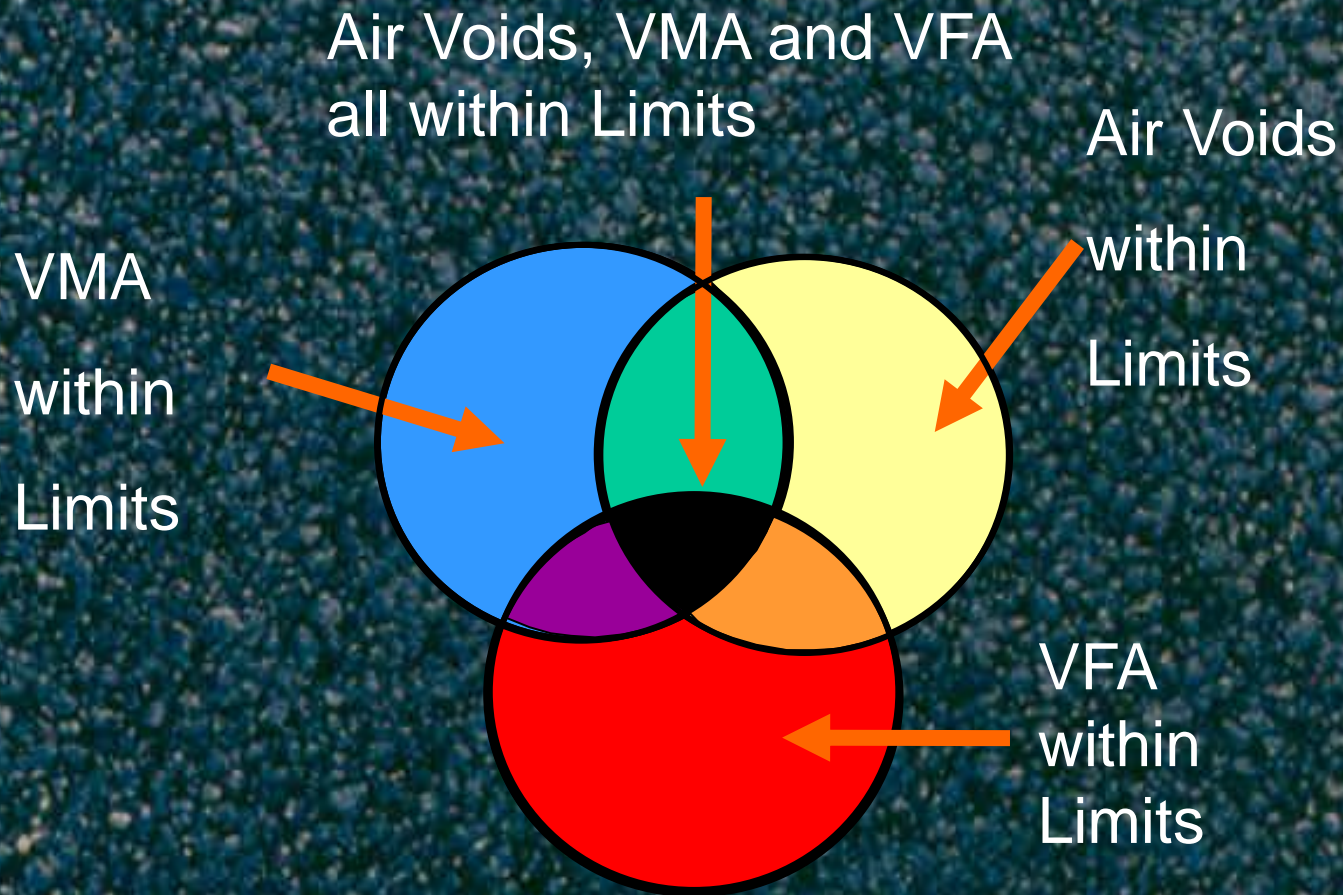
Asphalt  
Content  
in Specified  
Limits

# Dependent Variables

Both Air Voids and  
VMA within Limits



# Dependent Variables



# Statistics in Pavement Construction

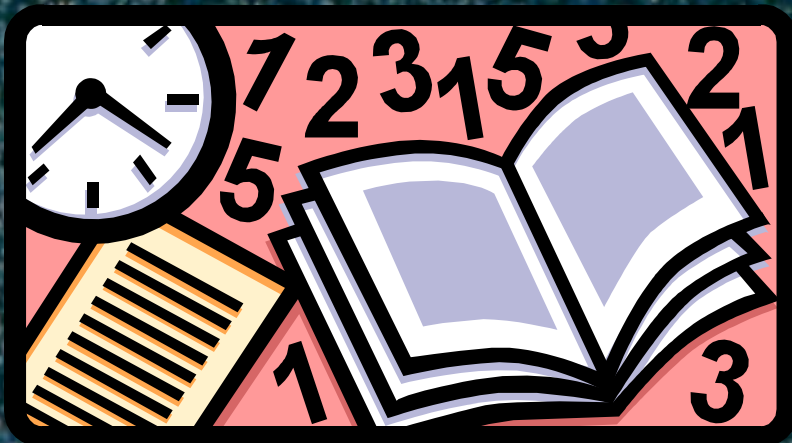




# Statistics

**The mathematics of the collection,  
organization, and interpretation of  
numerical data**

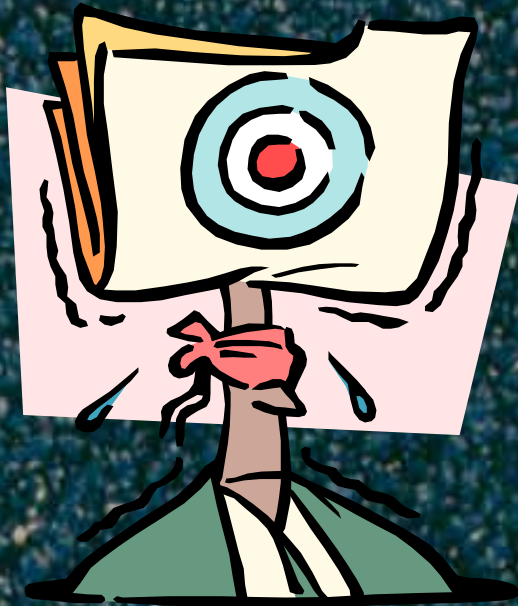
*American Heritage Dictionary*



# Statistics

**The science that scares the hell  
out of normal people.**

*Dale Decker*



# Accuracy Versus Precision



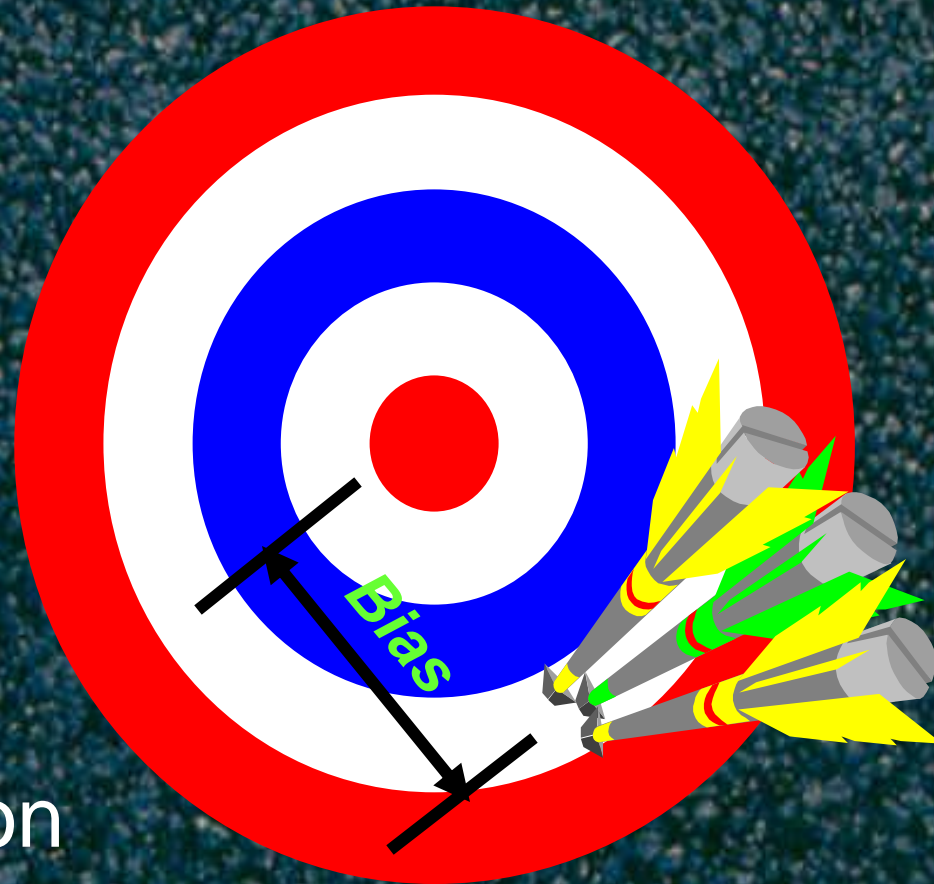
# Accuracy



Poor Precision

Good Accuracy (unbiased)

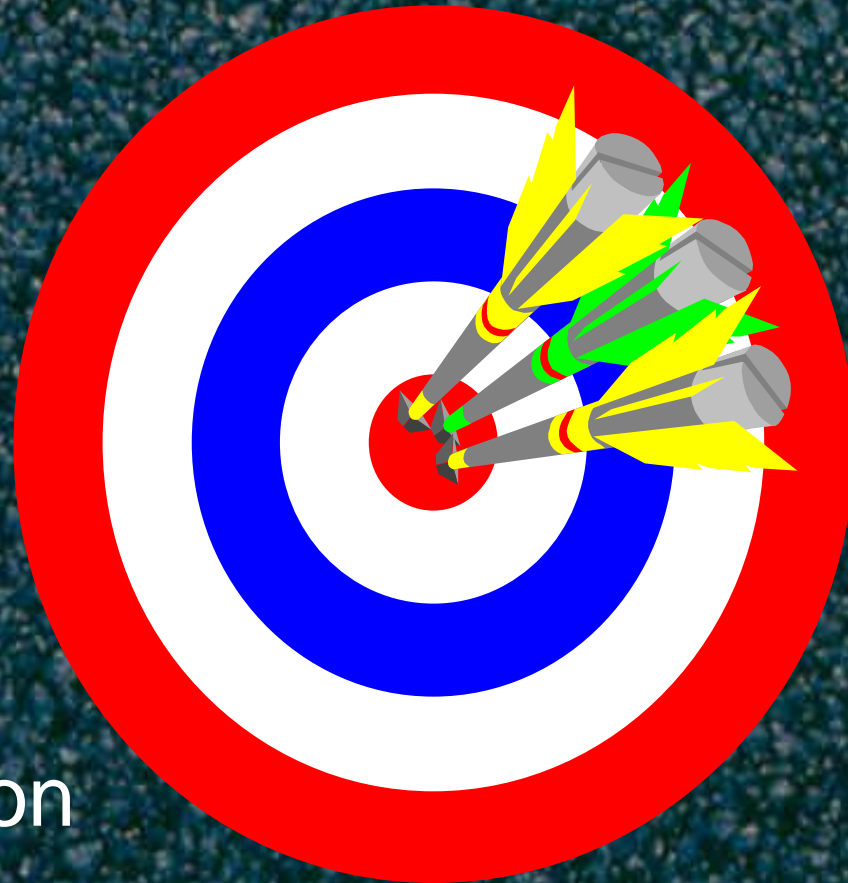
# Precision



Good Precision

Poor Accuracy (biased)

# Accuracy & Precision



Good Precision

Good Accuracy (unbiased)

# ***Risk Analysis***

**Good  
Material**

**Bad  
Material**

**Accept**



$\beta$



**Reject**

$\alpha$



# **We don't know what we know**

- **Good technology many times not used properly**
- **Test methods/design procedures “customized”**
- **“Don't have time” to do it properly**
- **NIH syndrome**



# Key Testing Parameters

- **Ignition Oven**
- **Maximum Specific Gravity (Gmm)**
- **Gradation**
- **Bulk Gravity of Compacted Mix (Gmb)**

**Specific Comments on potential sources of variability follow**

**It's easy to get lazy...**



<http://go.to/funpic>

# Diligence is Required



# For All Tests

- **Critical to follow standard test methods**
  - **Every technician in every lab must run every test exactly the same way!**
    - **Both contractor and DOT**
- **Tests are not an acceptable place for individuality!**

# Testing Highlights



**Important Notice  
for all Technicians**

# Ignition Oven

- **Use AASHTO requirements for sample weight**
- **Ensure oven is calibrated**
- **Verify complete burn**
- **Ensure that oven vent is not impeding exhaust gas flow**

# Maximum Specific Gravity

- **Use AASHTO requirements for sample preparation**
  - **Size of sample**
  - **Temperature**
  - **Timing for performing tests**
- **Calibrated vacuum system**
- **Proper water temperature**

# Gradation

- **Inspection of sieves**
  - **Wire**
  - **Soldering**
- **Don't overload sieves**
- **Verify weight for original versus retained sample to meet spec requirements**

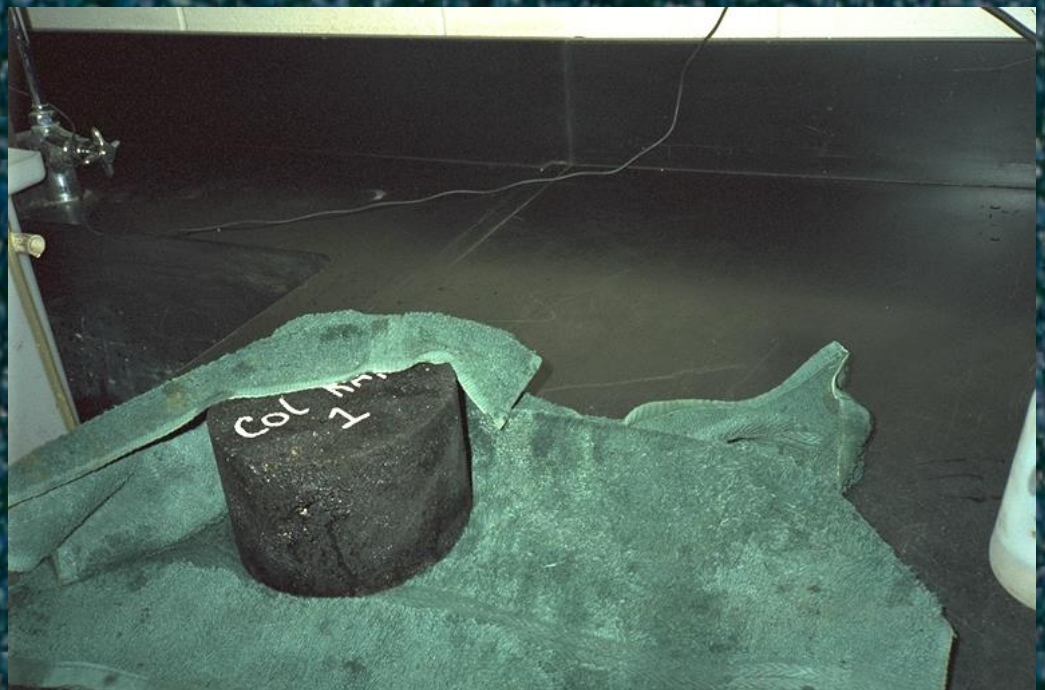


# **Aggregate Specific Gravity**

- **Critical materials property**
- **Can make a huge difference in volumetric calculations**
- **Must keep up-to-date**

# Bulk Gravity Test (Gmb)

- **Maintain water temperature and volume**
- **Consistency in getting SSD condition**



# Rule-of-Thumb

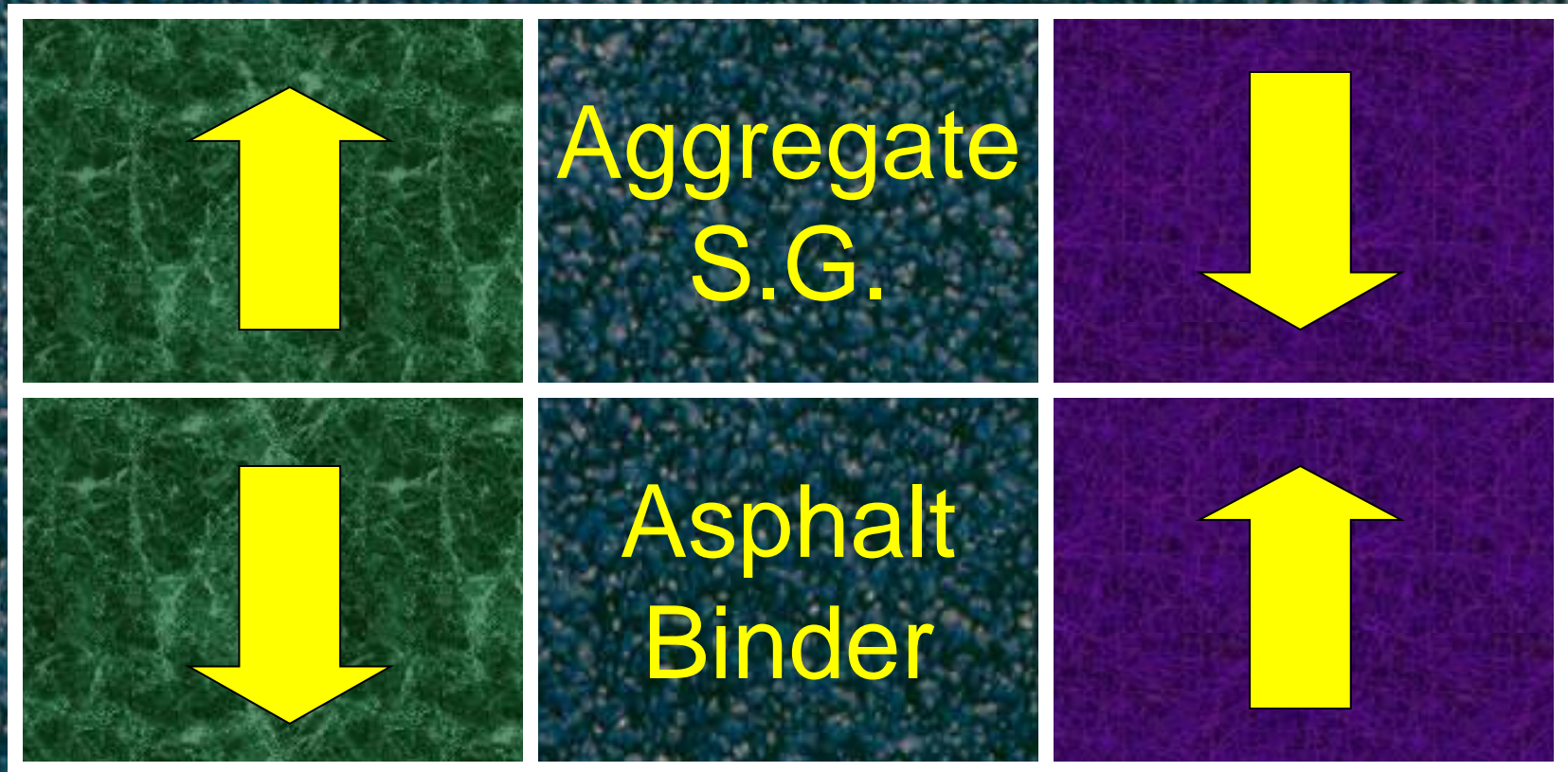
0.100 change in aggregate blend S.G.



Binder requirement changes 0.2% by wt

**To maintain equivalent asphalt content  
by volume for same VMA**

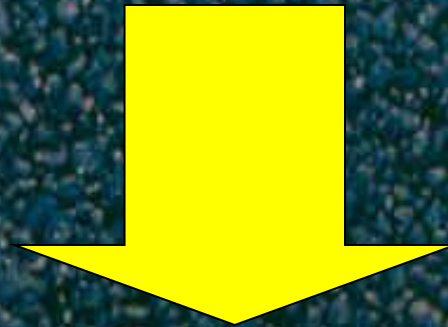
# Specific Gravity vs. Binder %



Does not account for binder changes due to absorption

# Variability

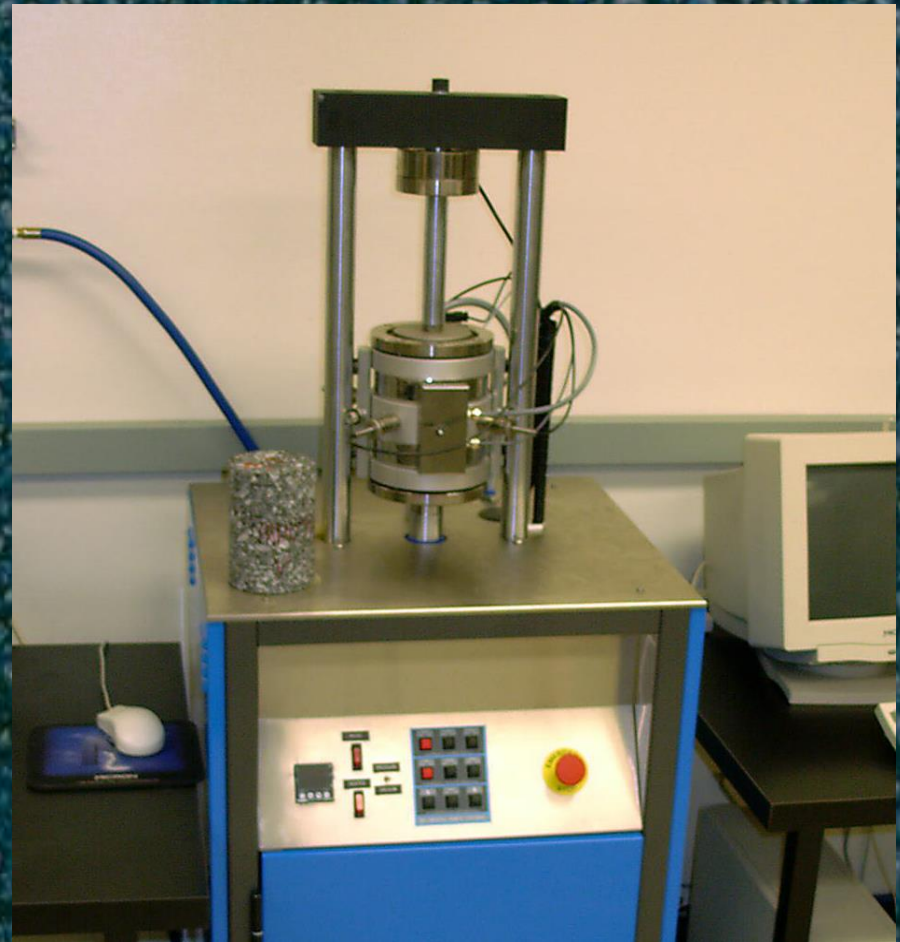
**Error in computing combined  
aggregate blend bulk S.G. of  
0.030**



**VMA error of ~ 1%**



# Performance Testing



# Performance Testing

- **Complicated process**
- **Challenge is to use lab data to predict performance on road**
- **Many variables in real world**



# **Key Elements for Performance Test**

- **Must be economical and easy-to-use**
- **Need standardized test**
- **Must be applicable to mix design and QC**
- **Procedure should be precise and accurate**
- **Results must correlate to field performance**

# Performance Testing

- **Critical to future development in industry**
- **Allows evaluation of new materials**
- **Can offer innovation opportunities for contractor**
- **Minimizes risk for design/build and warranty projects**



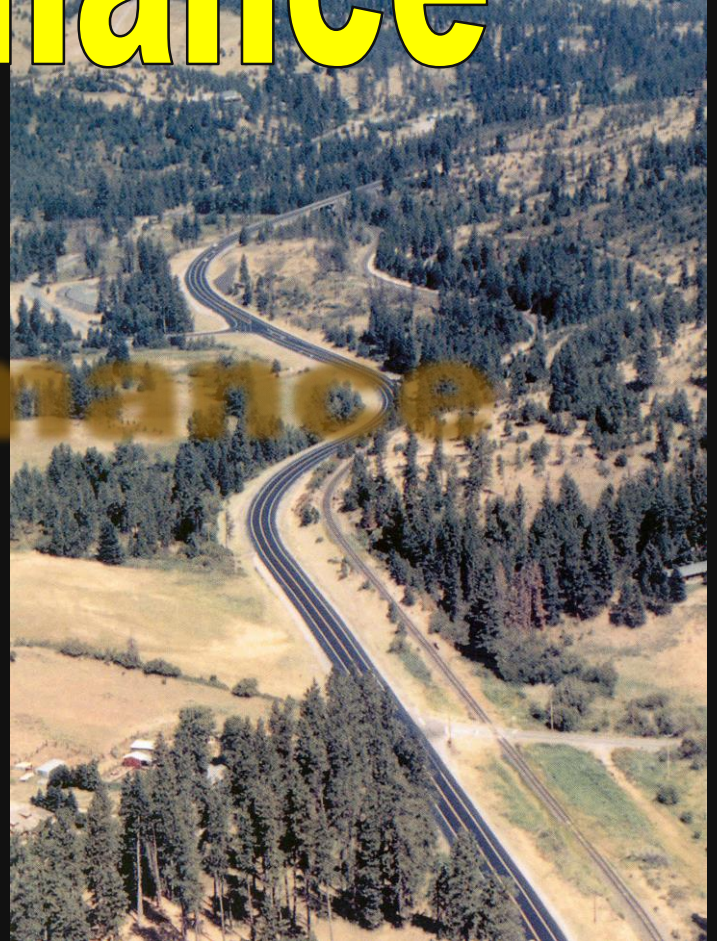


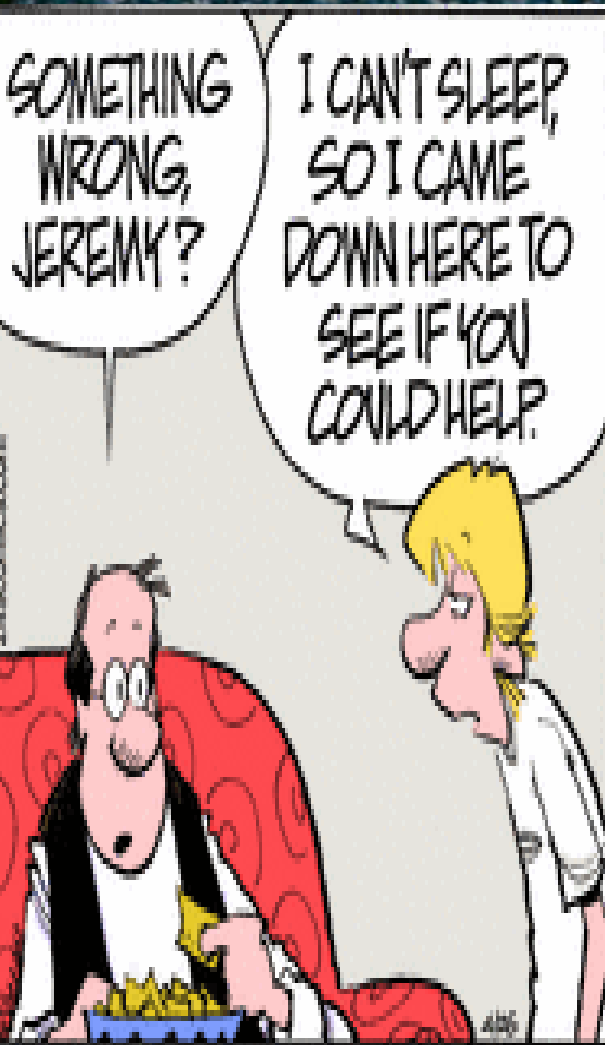
**Performance**



**is the**

**Key**





***Thank***

***You!***

**Dale S. Decker**

**Eagle, CO**

