

## Percent Within Limits

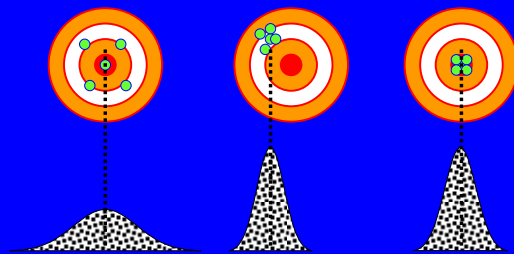
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Materials, mixtures, and test methods have variability so statistical specs are needed

Spec should encourage contractor to hit the target and have low variability

## Repeatability and Accuracy



Repeatability:	poor	good	good
Accuracy:	good	poor	good

## Error in test results include

- Material variability
- Sampling error
- Splitting error
- Testing error

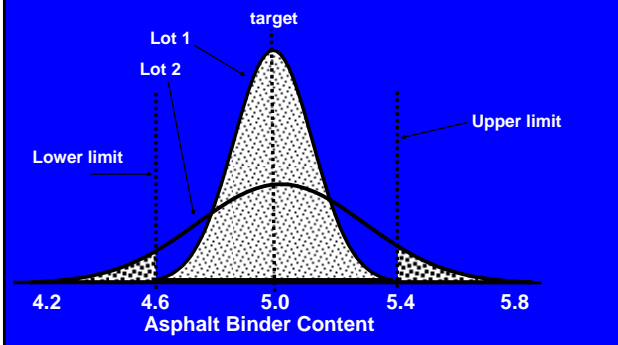
## Two Types of Statistical Specs Normally Used

- Percent within limits
- Mean absolute deviation
- Both types of specs encourage the contractor to hit the target and minimize variability
- Mean absolute deviation is approximately equal to 0.8 x standard deviation

## Percent within Limits

- PWL assumes that material within specs is good and material outside specs is bad
- If applied literally percent pay would probably be equal to percent within limits
- However, 10 percent defective will likely result in 100 percent repair

### Concept of Percent Within Limits



### Statistical terms that need to be understood

- Average
- Standard deviation
- Percent within limits
- Mean absolute deviation
- Lot
- Representative samples
- Random samples
- Stratified random samples

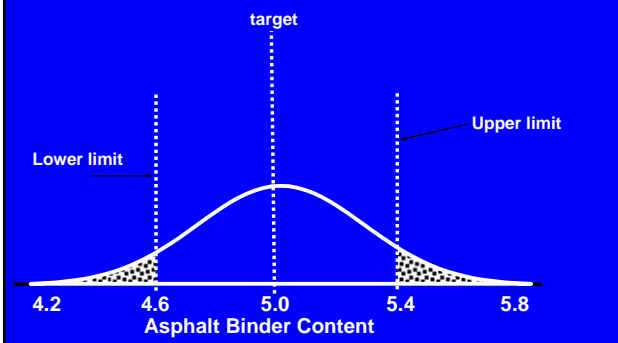
### Lot size

- How many samples per lot??? Typically 4 or 5
- More samples are better for analysis but test frequency may be too great
- Typically a lot is approximately equal to one day's production
- Typically lot size 2,000 to 4,000 tons

### Steps to be taken before adopting statistical spec

- Always do pilot projects before adopting statistical spec
- Tolerances must include sampling error, testing error, and normal material variability
- Make sure that test requirements are not set too tight initially. They can be adjusted later
- Use proper weight for individual pay factors
- Use offset from mean when setting limits
- Have a procedure for referee testing

### Establishing Limits for Percent Within Limits

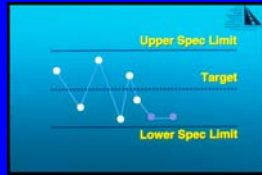


### Steps before adopting statistical spec (cont'd)

- Get industry involved in process
- In addition to random sampling owner should have right to test anywhere but must be careful in what test represents
- Pay clauses should match performance
- Identify properties for pay adjustments: voids, asphalt content, density, smoothness
- Contractor needs to have ability to make some amount of changes in the process
- Several years before statistical spec can be fully adopted

## Plot control charts

- Identify trends
- Determine when process is out of control
- Identify causes of changes in mix properties
- Summarize data



## TYPICAL TYPES OF CONTROL CHARTS

- INDIVIDUAL VALUES
- RUNNING AVERAGE

## Some issues with statistical specs

- Contractor vs. Government testing
- Verification of contractor test results---34 states use contractor test results
- How to reconcile differences between contractor and government test results---referee system
- How to handle outliers
- More trained technicians needed than available
- Training/certification

Statistical spec is needed for best control

Emphasis is on adoption of PWL

PWL and MAD systems work

The End