



U.S. Department of Transportation
Federal Highway Administration



Federal Highway Administration Resource Center

**Quality Assurance for Large Payment
Lots**

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U.S. Department of Transportation
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Variability
Payment Lot size
Validation of contractor data



Material



Process



Sampling



Testing

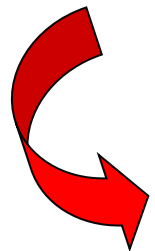


Material

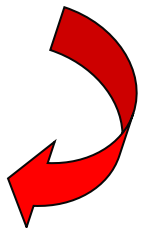
Process

Sampling

Testing



**Composite
Variability**





Standard Deviation:

- Sample standard deviation (s)

$$s = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n - 1}}$$

- Population standard deviation (σ)

$$\sigma = \sqrt{\frac{\sum (X_i - \mu)^2}{N}}$$

Percent within Limits (PWL)

- Using the sample data, with its mean and standard deviation, we can determine the quality level of the sample



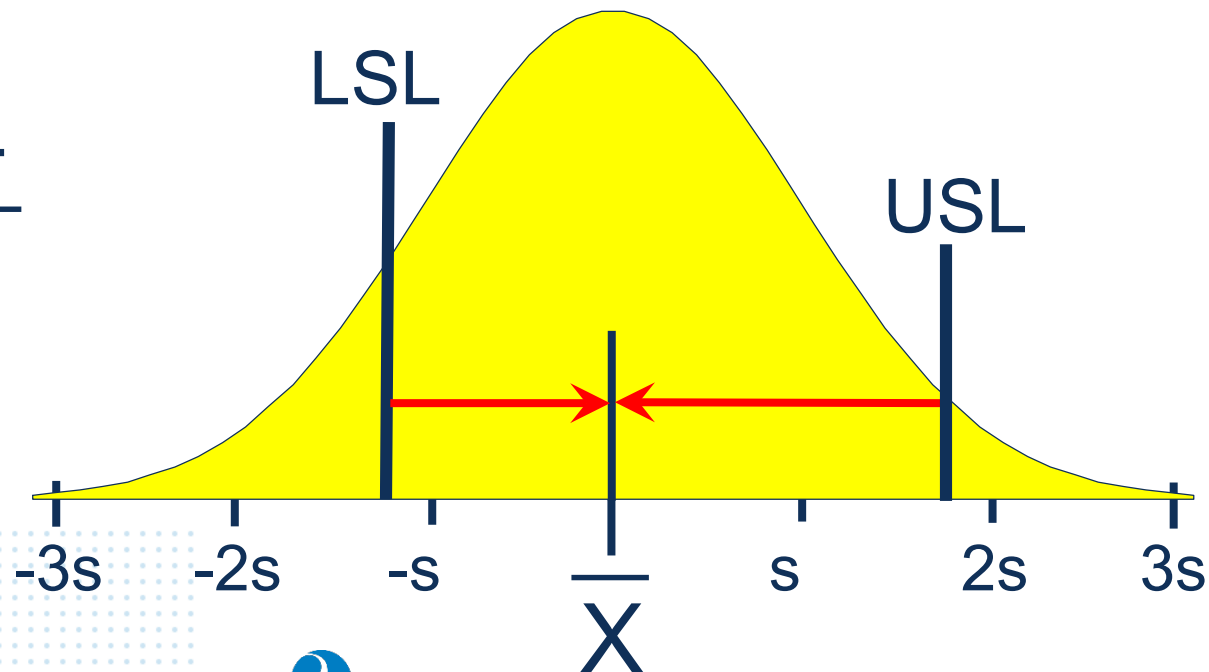
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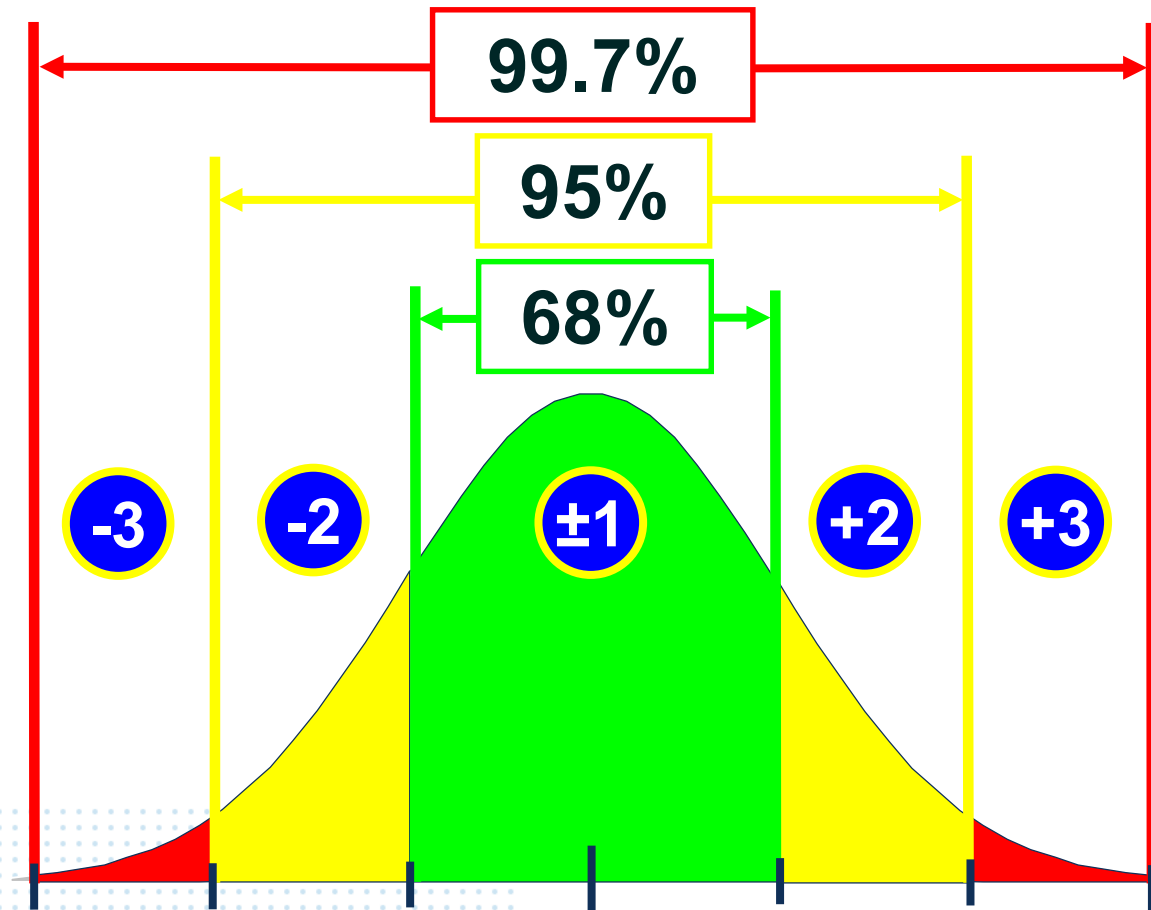
Compute Q

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

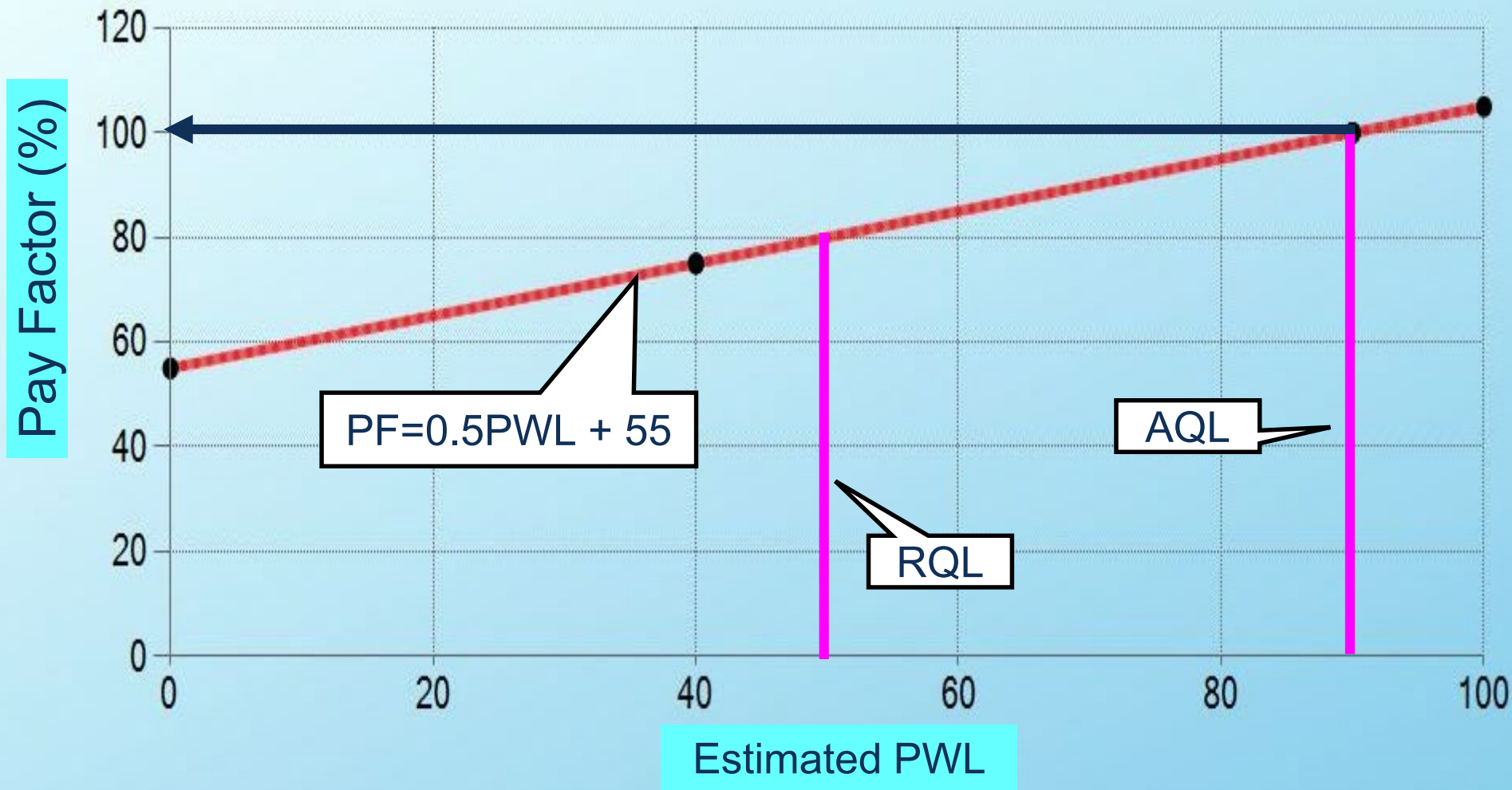
$$Q_L = \frac{\bar{X} - LSL}{s}$$



Data within $\pm$ Standard Deviation

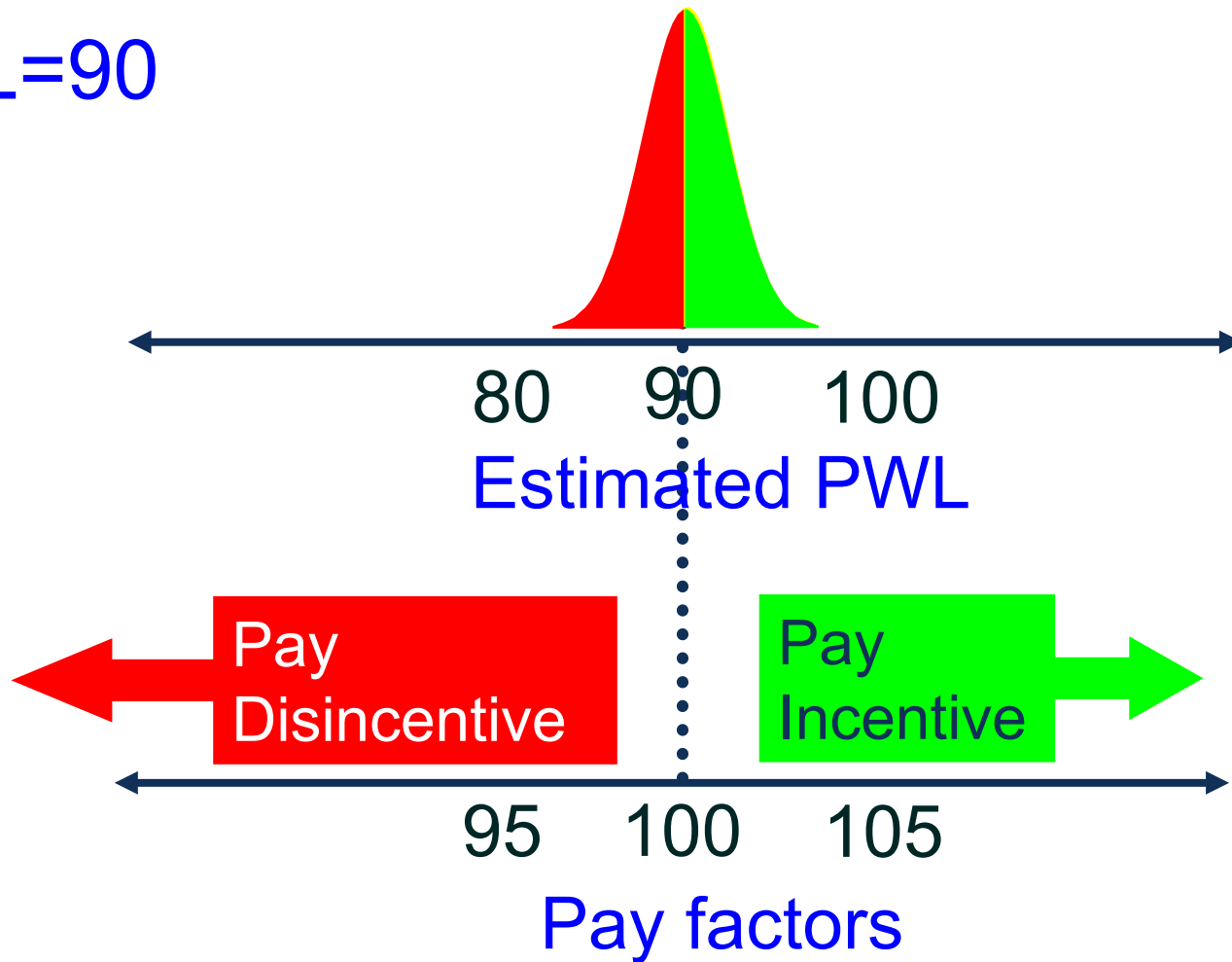


Payment Plan with 5% Incentive

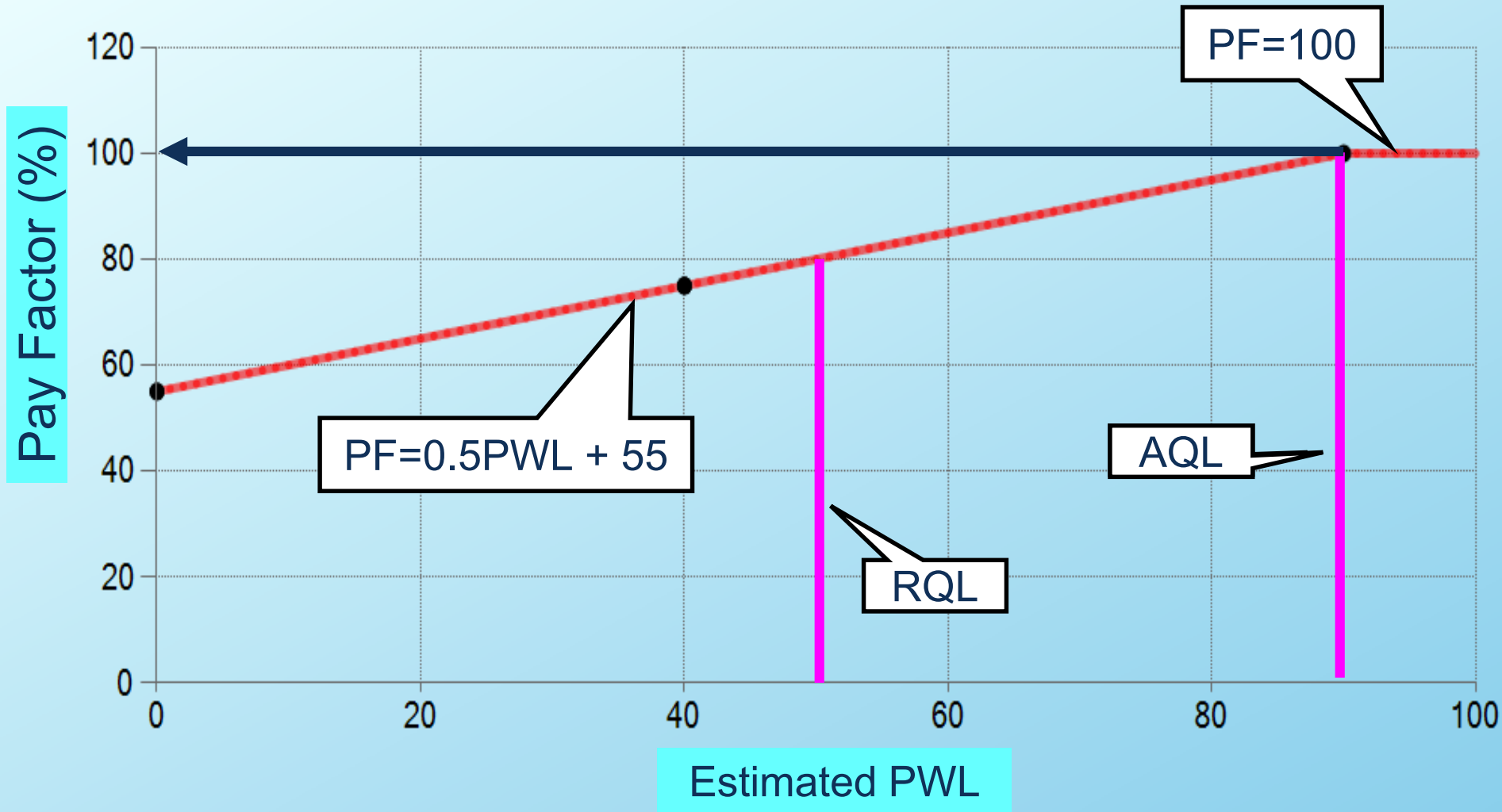


Payment Plan with Incentive

AQL=90

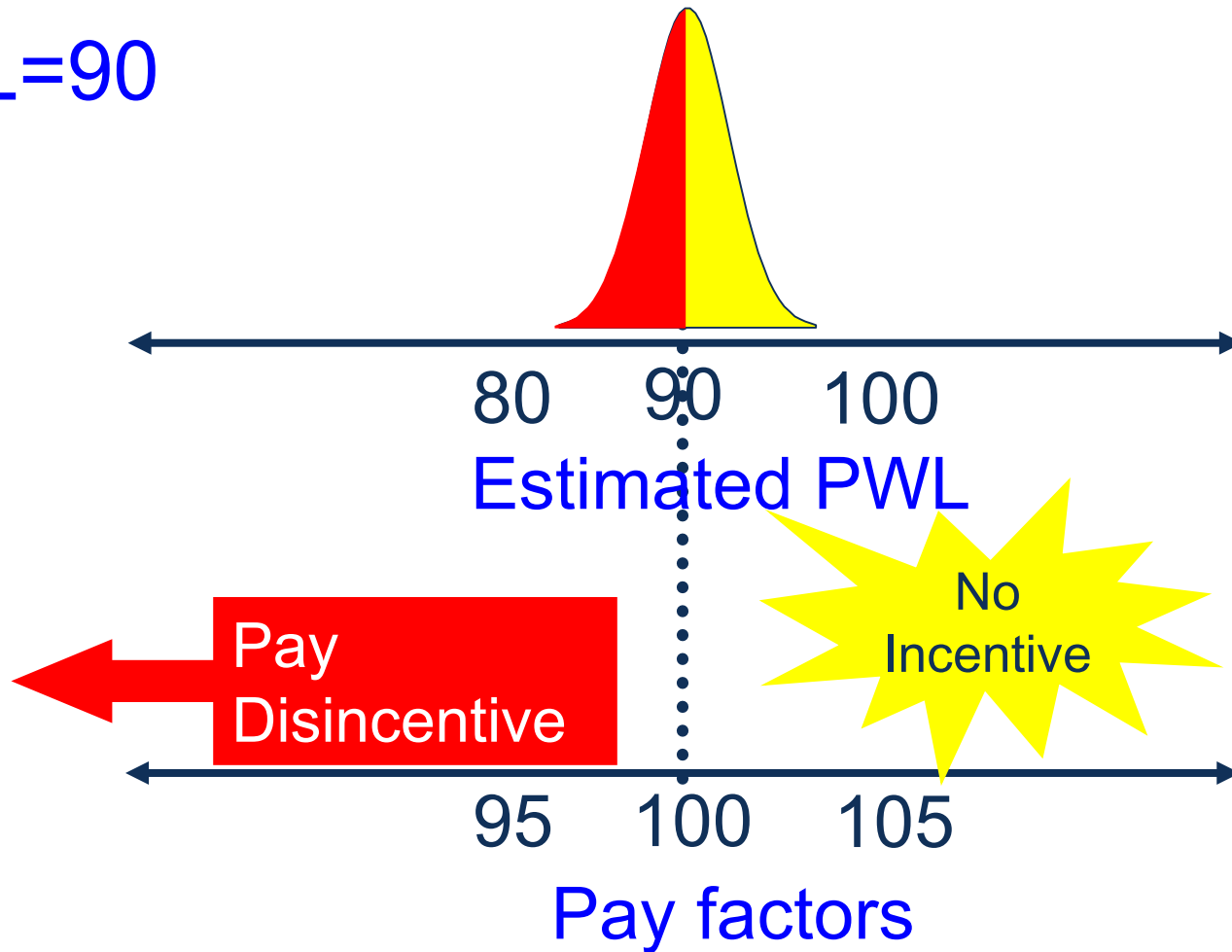


Payment Plan without Incentive



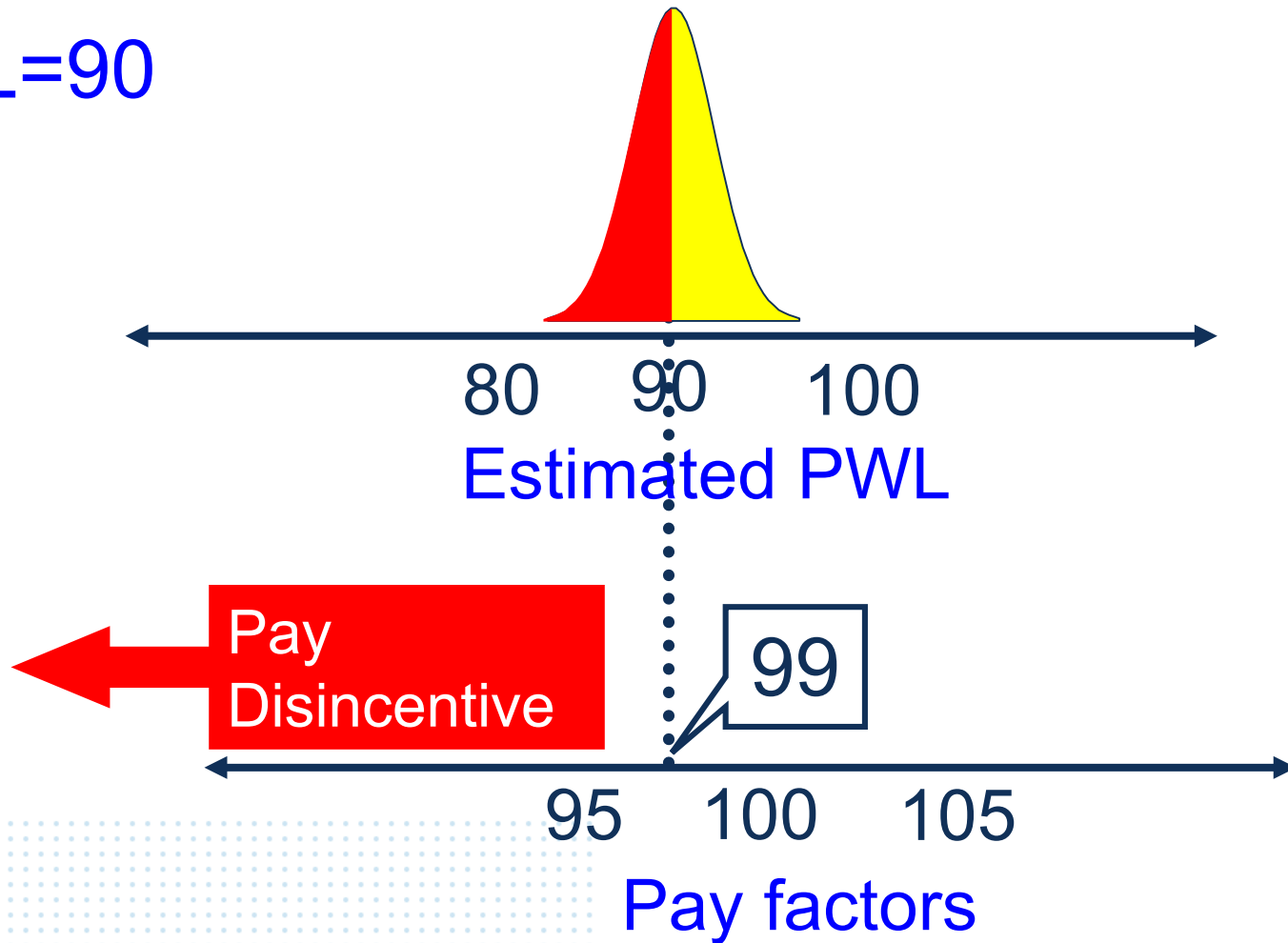
Payment Plan without Incentive

AQL=90

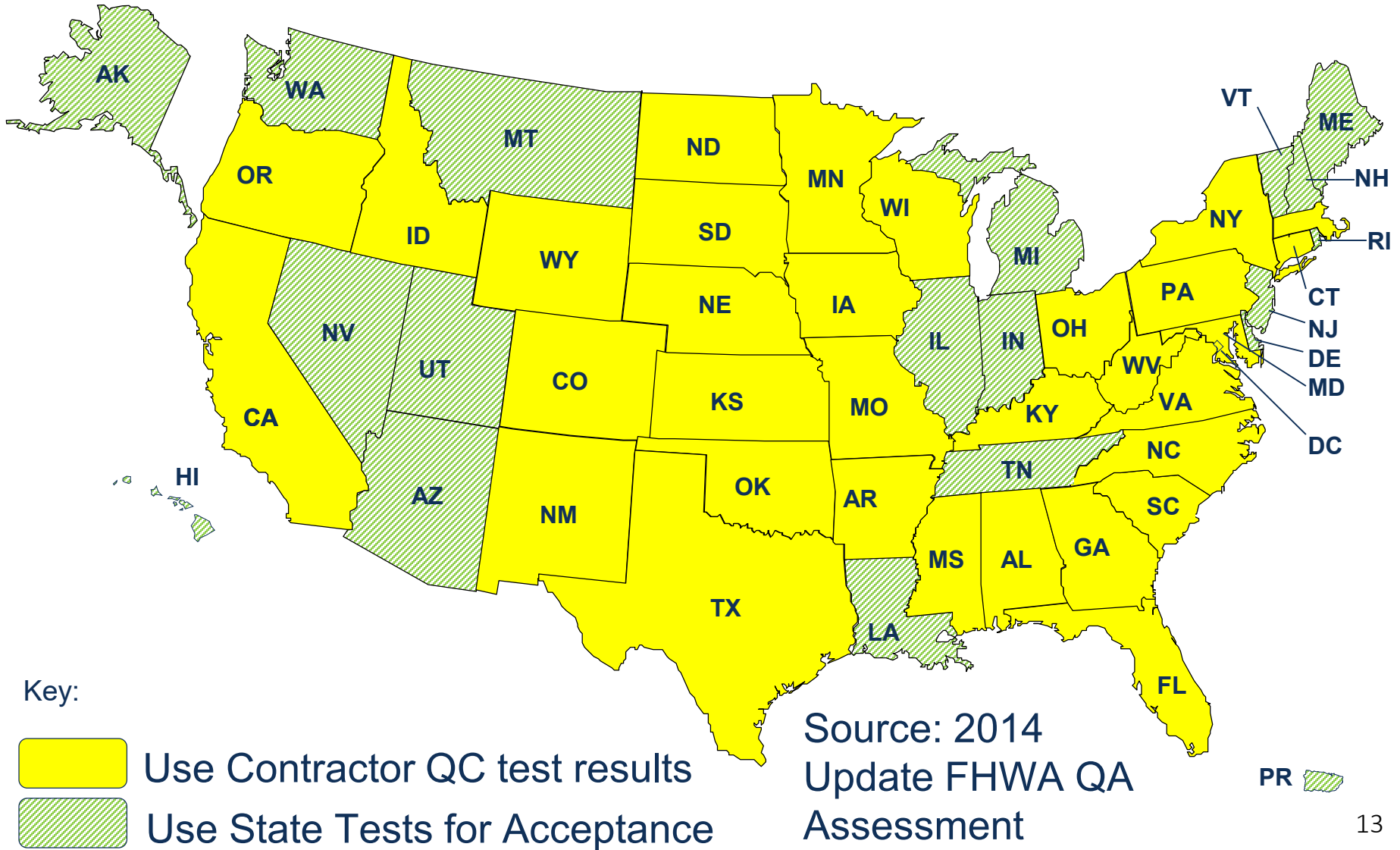


Payment Plan without Incentive

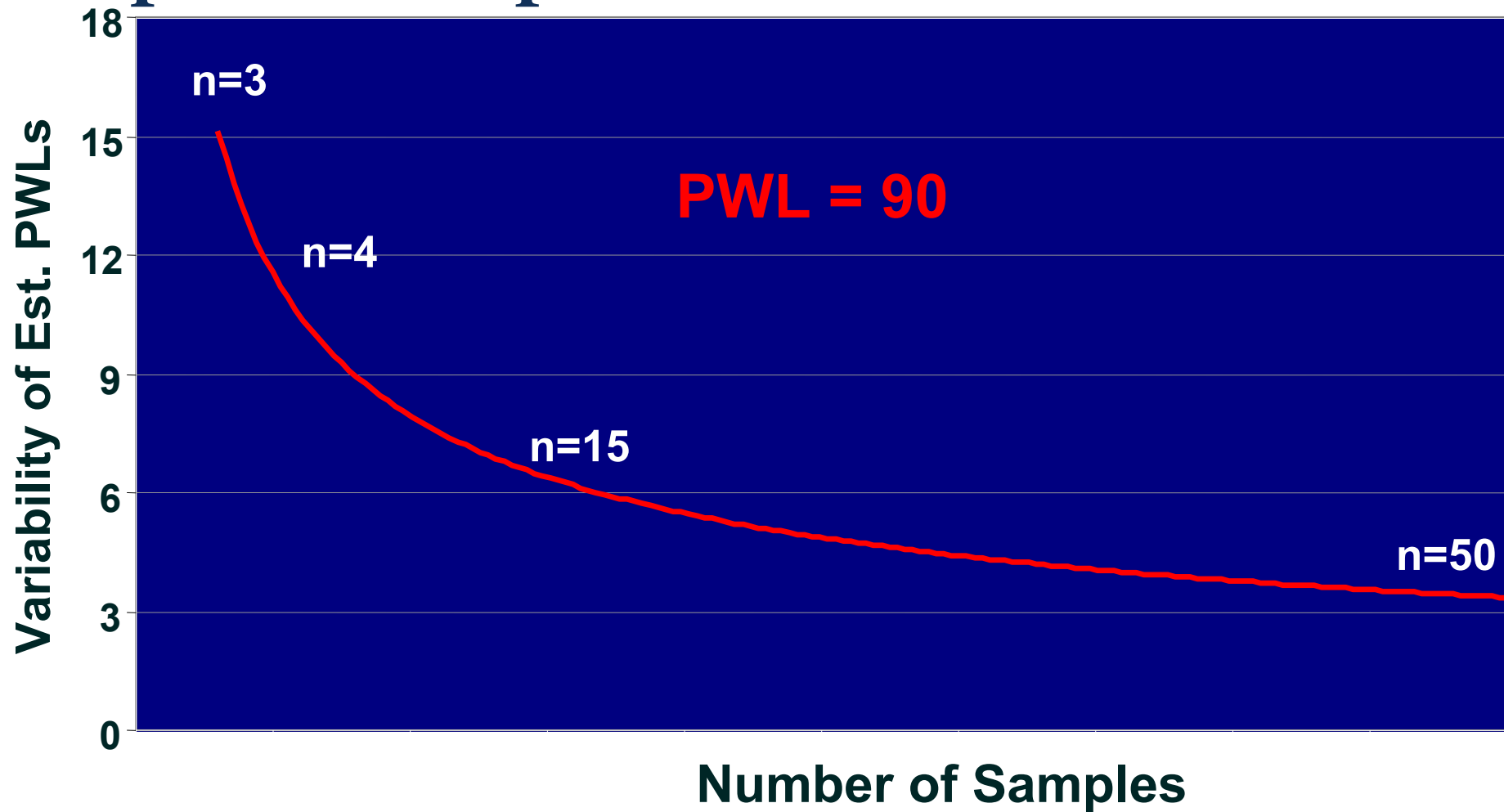
AQL=90



32 States use Contractor QC test results in the Acceptance Decision



Optimal Sample Size



Recommendations - number of tests in large payment lot

- Most states include 3-5 tests/lot
- Caltrans has largest number of tests in a payment lot with 20 QC tests and 7 QA tests per lot
- Recommend maximum of 30 QC tests per lot
 - Found that contractors could change quality during last few tests in a lot of about 50 tests without PWL identifying change
- Recommend new lot after 30 days of no production
- Continue ratio of 4 QC to 1 QA tests
- Use F&t statistical hypothesis tests to validate contractor tests for entire lot, rather than use comparison tolerance for each set of 4 QC tests and 1 QA test





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Validating Contractor and Agency Data Used in the Acceptance Decision



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Validation

- The mathematical comparison of two independently obtained sets of data to determine whether it can be assumed they came from the same population



Hypothesis Tests Used for Validation

- Two Hypothesis Tests
 - F-test compares variances (spread of data)
 - Variance is the standard deviation²
 - T-tests compare means (center of data)



Conducting F and t-tests

- The greater the number of tests, the greater the ability of the validation procedure to identify valid differences



Power of the F-test ($1-\beta$)

Ratio of Standard Deviations	Number of Contractor Tests 	Number of Agency Tests 	Probability of Detecting a Difference
2	10	3	0.10
	25	5	0.51
	30	5	0.53
	25	10	0.73
	30	10	0.75





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Questions?

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