NATIONAL ACADEMIES *Sciences Engineering Medicine*

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Quality Assurance of Transportation Materials and Construction—Part I

February 11, 2025

11:00 AM – 12:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING RCEP REGISTERED CONTINUING EDUCATION PROGRAM

Purpose Statement

This webinar will provide an introduction to quality assurance components; discuss variability, risks, and pay factors; and identify indicators of material certification testing fraud.

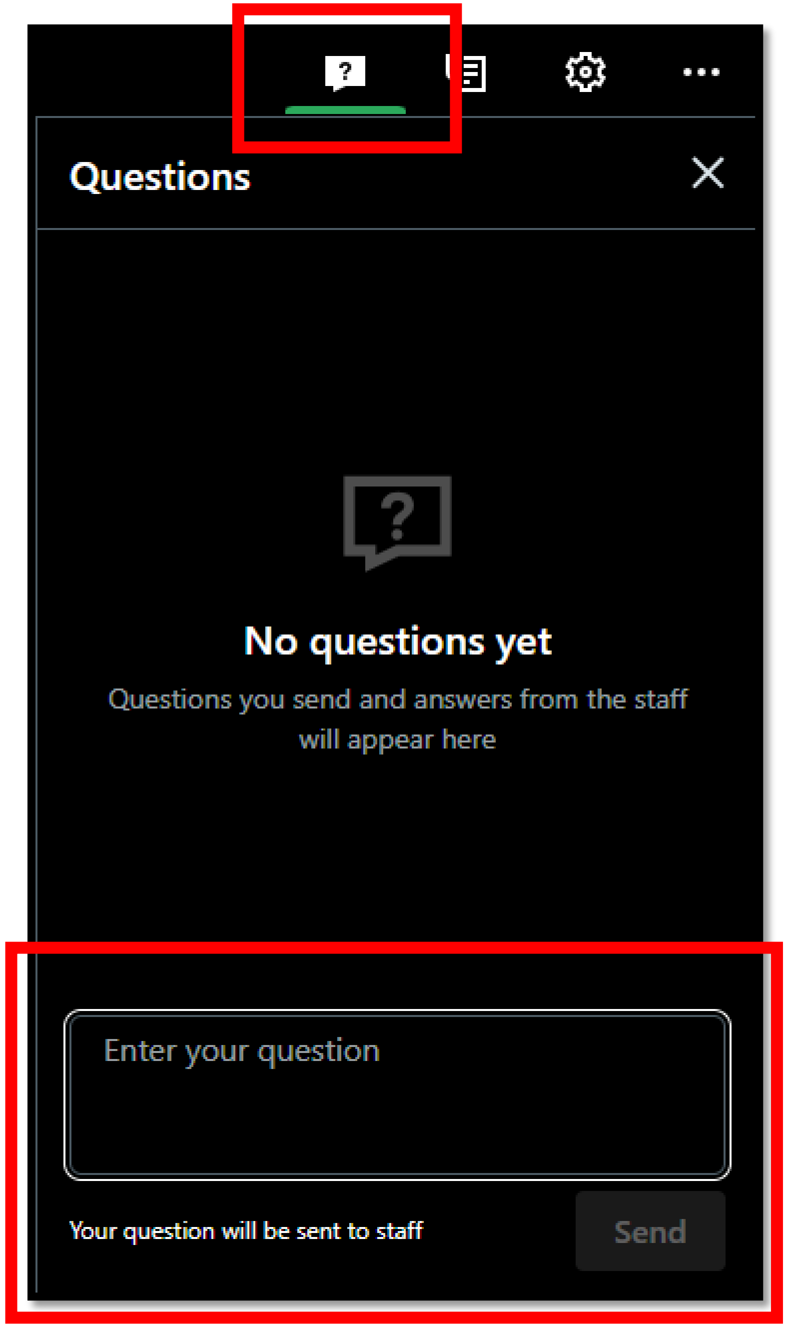
Learning Objectives

At the end of this webinar, you will be able to:

- Explore the basics of quality assurance and explain why it should be implemented by agencies.
- Understand the variability, risks, and pay factors from both the agency's and contractor's perspectives.
- Identify indicators for material certification and testing fraud.

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

Mark Felag
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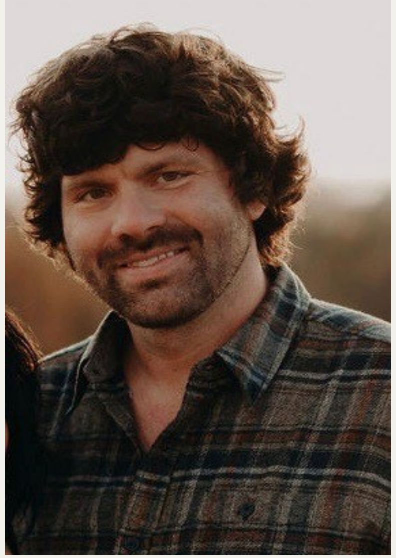

Mike Copeland
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Idaho Transportation Department

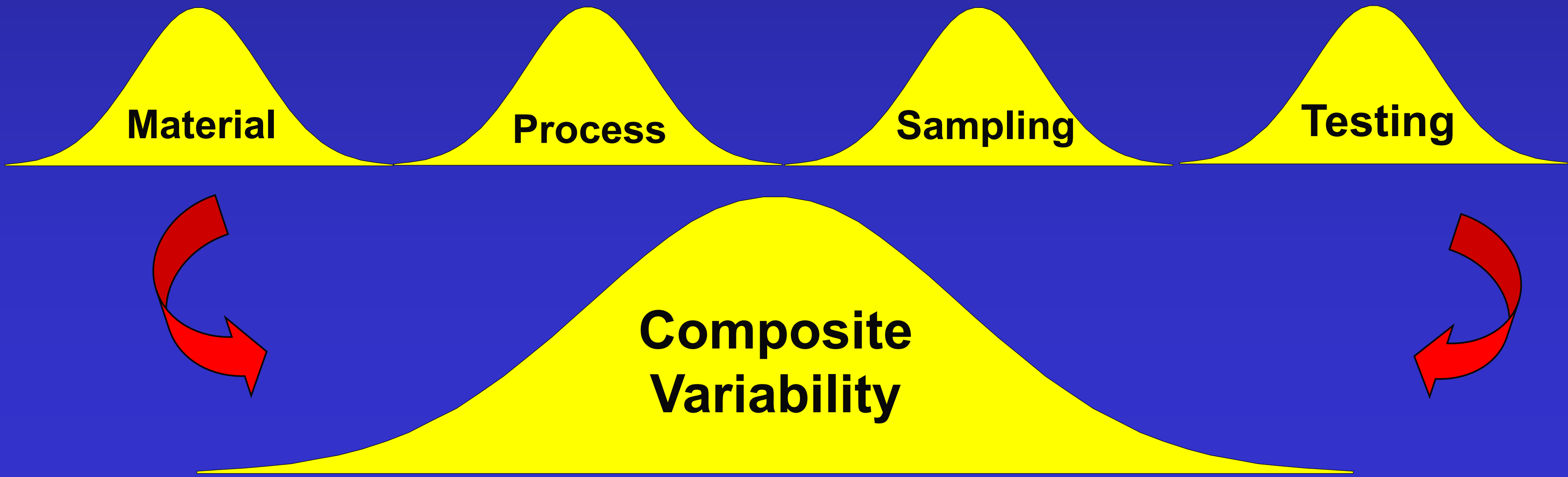
IDAHO TRANSPORTATION DEPARTMENT

Introduction to Quality Assurance Components

Dennis Dvorak

Sources of Variability

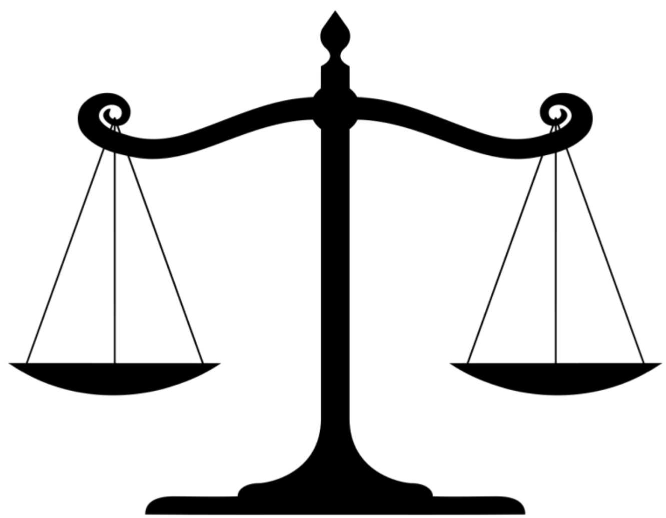
Material **Process** **Sampling** **Testing**



Risk Management

Testing and Inspection Costs

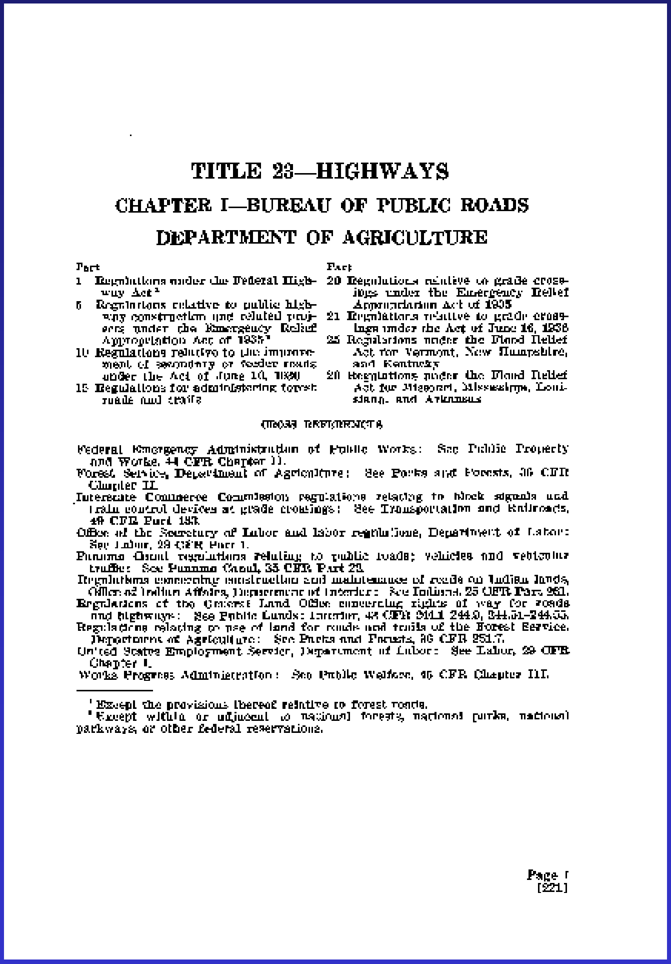
Material Quality and Performance Risk



23 Code of Federal Regulations (CFR) (1938)

Section 1.9 Construction

(b) Unless otherwise stipulated in writing by the Secretary or his authorized representative, *materials for the construction of any project shall be tested, prior to use*, for conformity with the specifications, according to methods prescribed or approved by the Bureau of Public Roads.



TITLE 23—HIGHWAYS

CHAPTER I—BUREAU OF PUBLIC ROADS

DEPARTMENT OF AGRICULTURE

Part
1 Regulations under the Federal Highway Act [1]
6 Regulations relative to public highway construction and related projects under the Emergency Relief Appropriation Act of 1935 [2]
10 Regulations relative to the improvement of secondary or feeder roads under the Act of June 16, 1936
15 Regulations for administering forest roads and trails

Part
20 Regulations relative to grade crossings under the Emergency Relief Appropriation Act of 1935
21 Regulations relative to grade crossings under the Act of June 16, 1936
25 Regulations under the Flood Relief Act for Vermont, New Hampshire, and Kentucky
26 Regulations under the Flood Relief Act for Missouri, Mississippi, Louisiana, and Arkansas

CROSS REFERENCES

Federal Emergency Administration of Public Works: See Public Property and Works, 44 CFR Chapter II.
Forest Service, Department of Agriculture: See Parks and Forests, 36 CFR Chapter II.
Interstate Commerce Commission regulations relating to block signals and train control devices at grade crossings: See Transportation and Railroads, 49 CFR Part 153.
Office of the Secretary of Labor and labor regulations, Department of Labor: See Labor, 29 CFR Part 1.
Panama Canal regulations relating to public roads; vehicles and vehicular traffic: See Panama Canal, 35 CFR Part 23.
Regulations concerning construction and maintenance of roads on Indian lands, Office of Indian Affairs, Department of Interior: See Indians, 25 CFR Part 261.
Regulations of the General Land Office concerning rights of way for roads and highways: See Public Lands: Interior, 43 CFR 244.1 244.9, 244.51–244.55.
Regulations relating to use of land for roads and trails of the Forest Service, Department of Agriculture: See Parks and Forests, 36 CFR 251.7.
United States Employment Service, Department of Labor: See Labor, 29 CFR Chapter I.
Works Progress Administration: See Public Welfare, 45 CFR Chapter III.

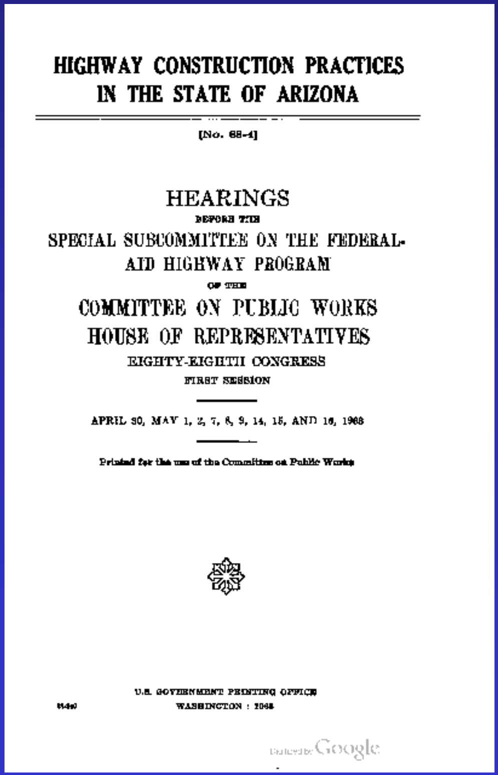
[1] Except the provisions thereof relative to forest roads.
[2] Except within or adjacent to national forests, national parks, national parkways, or other federal reservations.

Page 1
[221]

Special Committee on the Federal-aid Highway Program

House of Representatives Committee on Public Works

Commonly known as the Blatnik Committee



HIGHWAY CONSTRUCTION PRACTICES
IN THE STATE OF ARIZONA

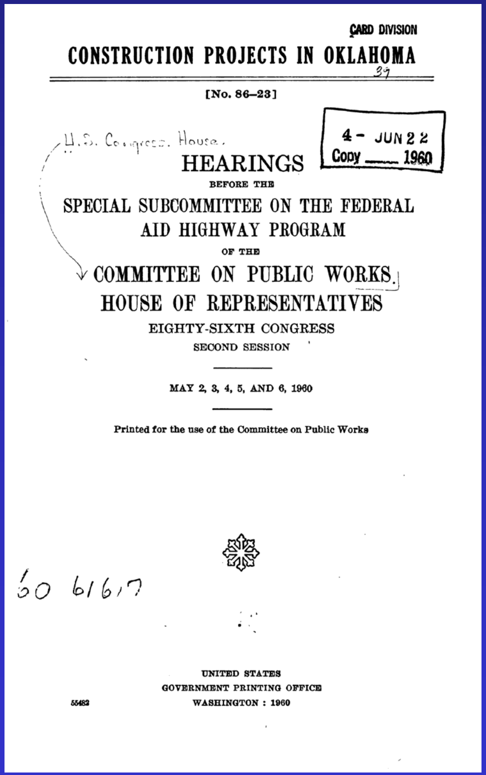
[No. 88-4]

HEARINGS
BEFORE THE
SPECIAL SUBCOMMITTEE ON THE FEDERAL-AID HIGHWAY PROGRAM
OF THE
COMMITTEE ON PUBLIC WORKS
HOUSE OF REPRESENTATIVES
EIGHTY-EIGHTH CONGRESS
FIRST SESSION

APRIL 30, MAY 1, 2, 7, 8, 9, 14, 15, AND 16, 1963

Printed for the use of the Committee on Public Works

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1963



CONSTRUCTION PROJECTS IN OKLAHOMA

[No. 86–23]

HEARINGS
BEFORE THE
SPECIAL SUBCOMMITTEE ON THE FEDERAL AID HIGHWAY PROGRAM
OF THE
COMMITTEE ON PUBLIC WORKS
HOUSE OF REPRESENTATIVES
EIGHTY-SIXTH CONGRESS
SECOND SESSION

MAY 2, 3, 4, 5, AND 6, 1960

Printed for the use of the Committee on Public Works

UNITED STATES
GOVERNMENT PRINTING OFFICE
55482 WASHINGTON : 1960

23 CFR 637 (1975)

- Subpart B – Sampling and Testing of Materials and Construction added to 23 CFR 637
- Each State DOT required to develop sampling and testing program including:
  - Acceptance samples and tests by State DOT
  - Independent Assurance (IA) samples and tests
  - Project materials certification for all Federal-aid construction projects

FHWA Federal-aid Program Manual (FHPM) 6-4-2-10 on Quality Assurance (QA) Program (1981)

- QA Program could include *process control sampling and testing by contractor*

23 CFR 637 (1995)

- Subpart B revised to allow the use of contractor QC tests as part of the acceptance decision
- State QA Program required to be approved by FHWA (Approval delegated to Division Office)
  - Frequency guide schedule for sampling and testing

Applicability of 23 CFR 637

- Applies to projects on the National Highway System (NHS)
- State administered and locally administered projects administered under 23 CFR
- Includes Design-Build projects

Core Elements of a Quality Assurance Program

Source: FHWA

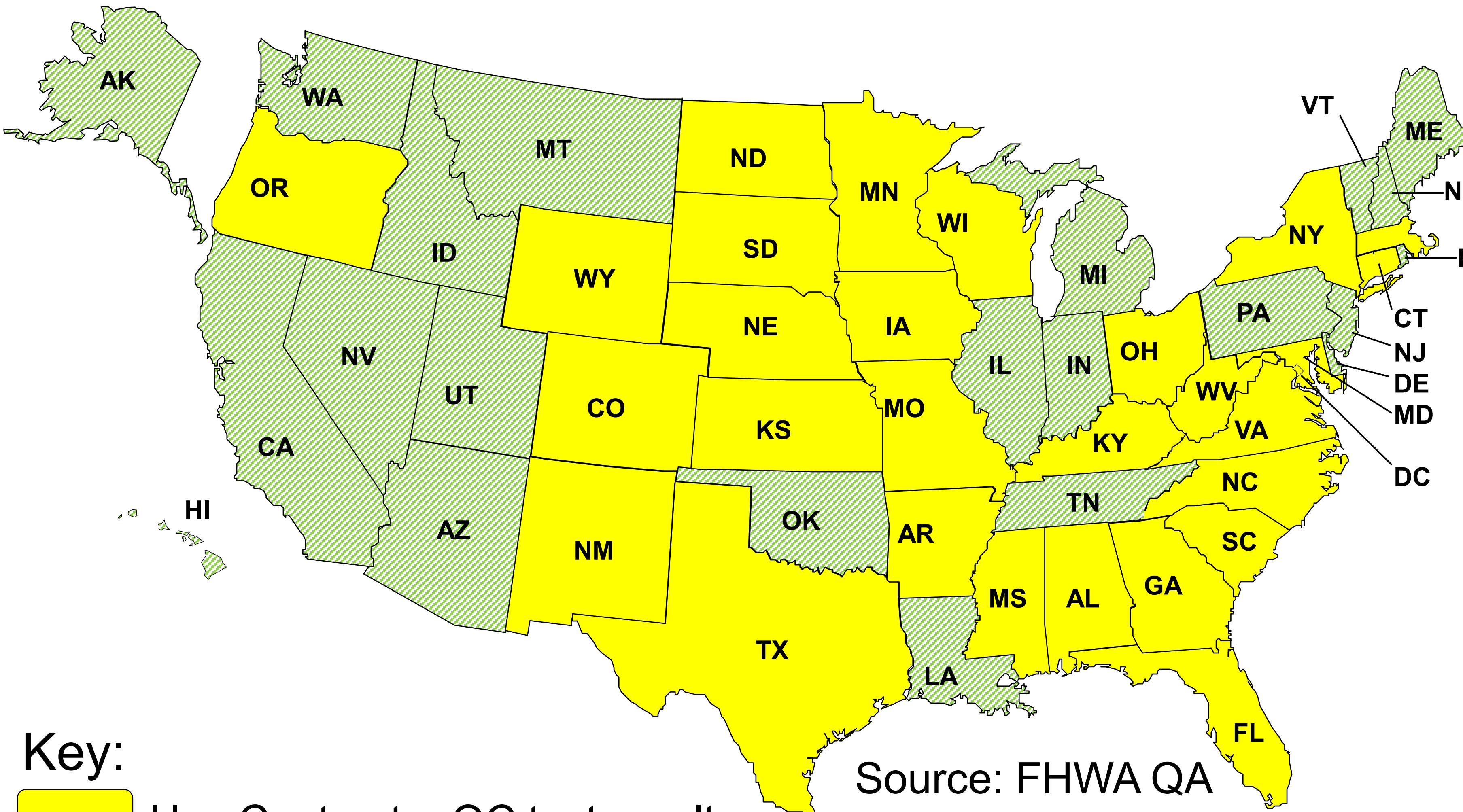
Contractor Quality Control (QC)

- Materials sampling & testing
- If part of acceptance decision
  - Independent of agency verification
  - Qualified technicians
  - Qualified laboratories
  - Independent assurance evaluation

Agency Acceptance

- Verification sampling & testing
- Acceptance & payment
  - May include contractor test results if validated

States using Contractor QC test results in the Acceptance Decision



Key:

Use Contractor QC test results

Use State Tests for Acceptance

Source: FHWA QA Assessment

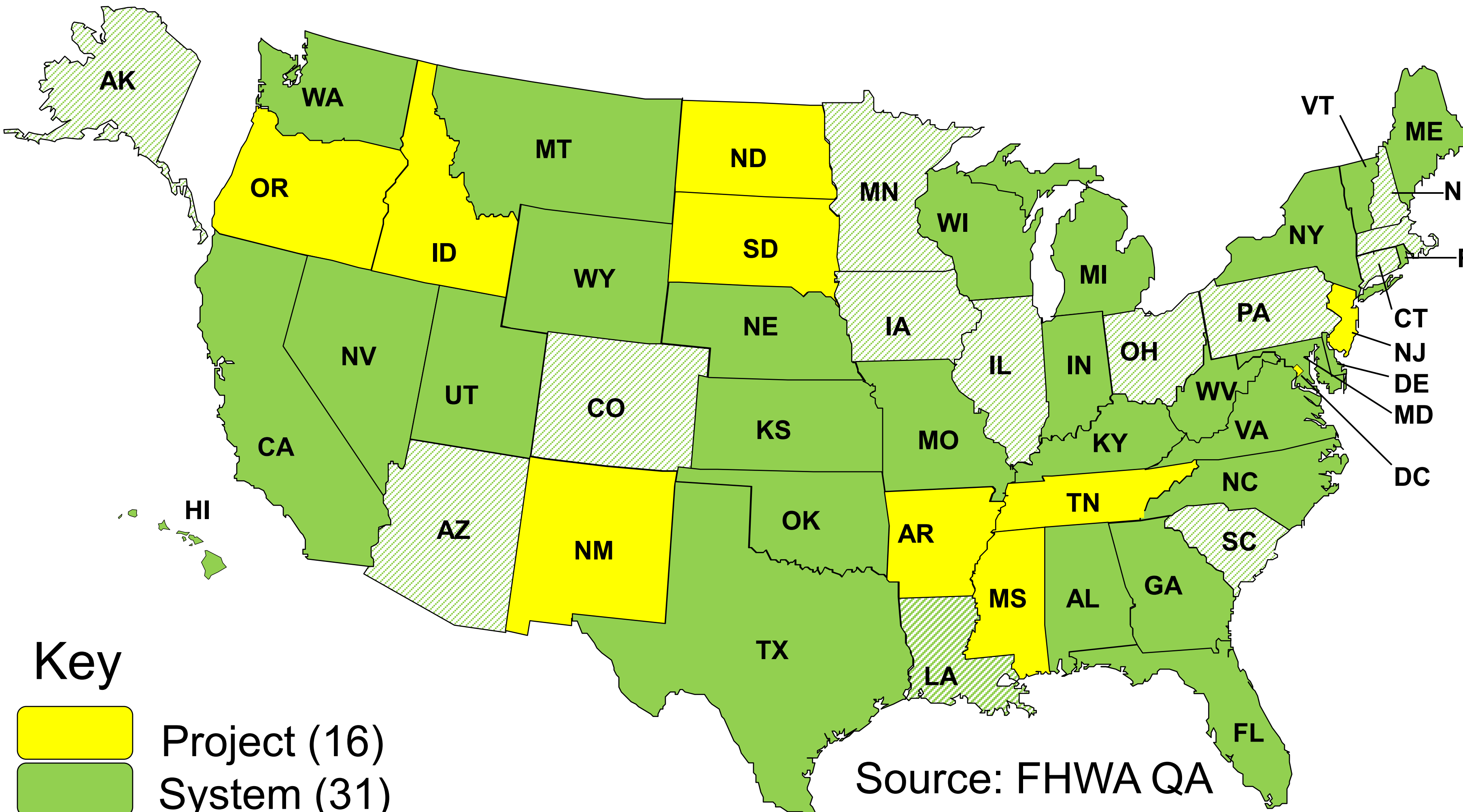
Independent Assurance (IA)

- Evaluate all acceptance sampling & testing
- Separate from acceptance testing
- Technician procedure evaluation
  - Observation
  - Split samples
  - Proficiency samples
- Testing equipment evaluation
  - Calibration checks
  - Split samples
  - Proficiency samples

IA Approaches

- Project Approach
- Systems (Program) Approach

Type of Independent Assurance Program Used



Key

- Project (16)
- System (31)
- Hybrid (5)

Source: FHWA QA Assessment

Technician Qualification

- Required for all sampling & testing in acceptance decision
- Qualification programs
  - State programs
  - Regional partnerships
  - National programs

Note: Technician qualification requirement can be found at 23 CFR 637.209(b).

Personnel Qualification and Certification

- Programs that certify are not materially different from programs that qualify personnel

Requirements for Personnel Qualification/Certification

- Recommended program guidelines:
  - Formal training; hands-on training
  - On-the-job training
  - Written and performance examinations
  - Periodic re-qualification (typically 2-5 years)
  - Process to remove personnel performing procedures incorrectly, falsifying statements or data

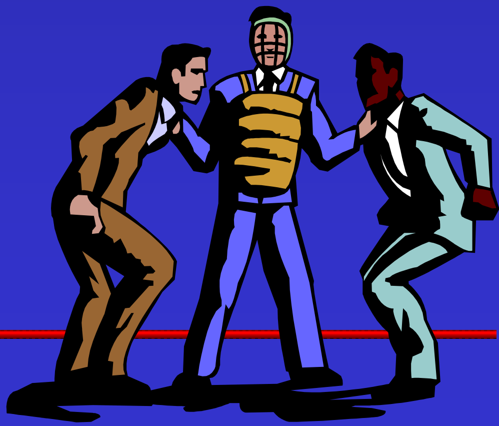
Laboratory Accreditation/Qualification

- Accreditation required
  - Agency central lab
  - Consultant dispute resolution labs
  - Consultant independent assurance labs
- Qualification required
  - Testing labs used in acceptance decision
    - Agency verification testing
    - Contractor QC testing

Dispute Resolution

- Formal system designed to address significant differences between partners data of such magnitude to impact payment
- Required when contractor data used in acceptance decision
- Can be performed within the State DOT
- Accredited third party laboratory can be used.

Note: See 23 CFR 637.207(a)(1)(iii) and 23 CFR 637.205(a) for more information.



Consultants for Testing and Inspection

- Agency retains project responsibility
- Conflict of interest – exclusive project roles
  - Agency verification
  - Independent assurance
  - Contractor QC
  - Dispute resolution

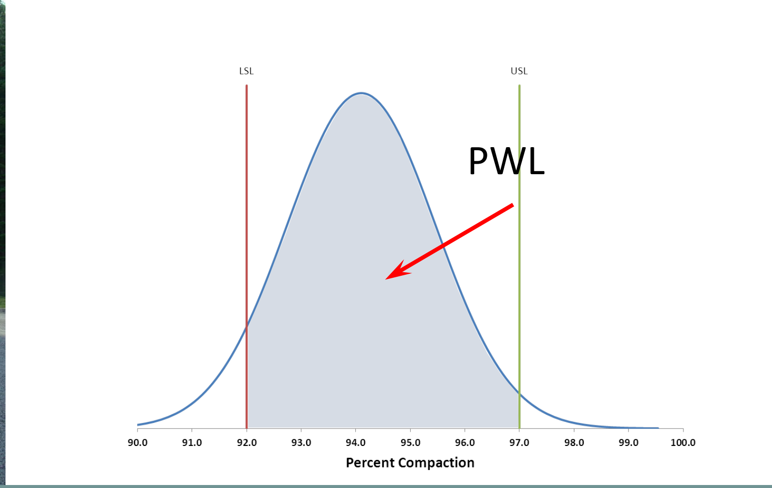
Note: See 23 CFR 637.209(c) for more information.

Random Sampling

- All samples used in the acceptance decision for quality control and verification sampling and testing shall be random samples
  - All materials will have an equal probability of being sampled
  - Removes Bias
  - Reduces potential for fraud

Note: See 23 CFR 637.205 for more information.





Evaluating Acceptance and Payment Risk

TRB Webinar: Quality Assurance of Transportation Materials and Construction—Part I

February 11, 2025

INTEGRITY • COMPETENCE • SERVICE

MaineDOT

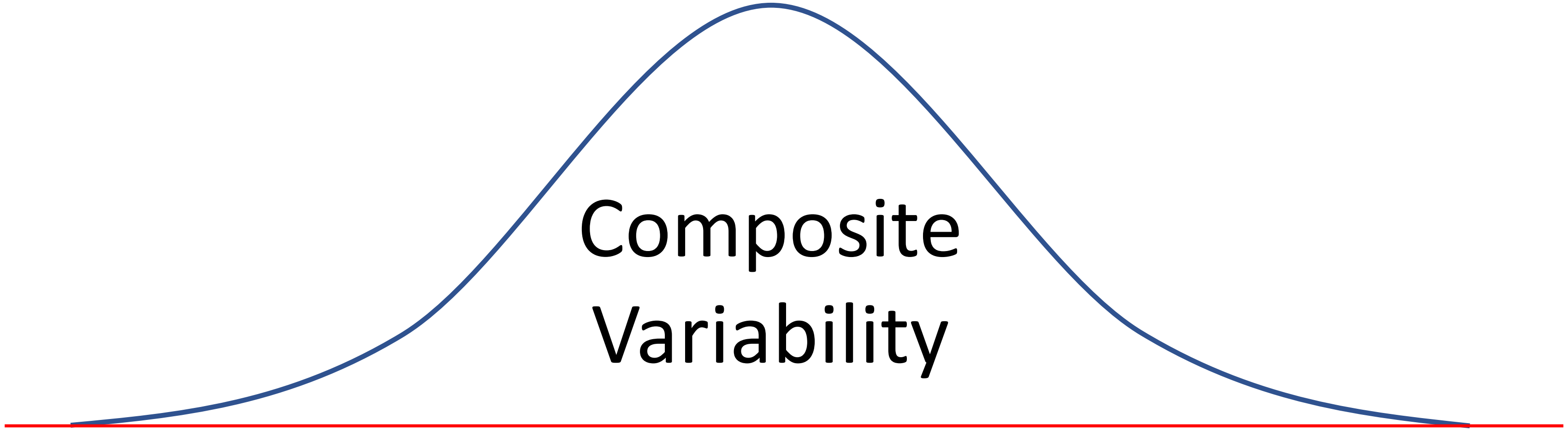
Acceptance plan risk

Richard Weed:
Determining risk is "an absolutely vital step"

Chuck Hughes:
"A very important ingredient in calculating risk is to get a reasonably accurate measure of variability."

Four sources of variability

- Materials
- Construction
- Sampling
- Testing



Materials variability

- Components used to produce item of work
- Examples:
  - Aggregates
  - Asphalt binder
  - Cement
  - Additives
- Each has some level of variability

Material

501.02 Conform to the following Section and Subsections:

Coarse aggregate for concrete	703.02
Concrete curing material and additives	711
Fine aggregate for concrete	703.01
Hydraulic cement	701.01
Pozzolans	701.03
Reinforcing steel	709.01
Sealants, fillers, and seals	712.01
Water for cementitious materials	725.01(a)

Construction variability

- Also called “Process variability”
- Convert materials into a product
  - Proportioning
  - Heating
  - Mixing
  - Transport
  - Installation & Finishing

Testing variability

- Variability between test results on the same material
  - Repeatability – Same technician & equipment
  - Reproducibility – Different technicians & equipment
- Precision estimates published in test methods

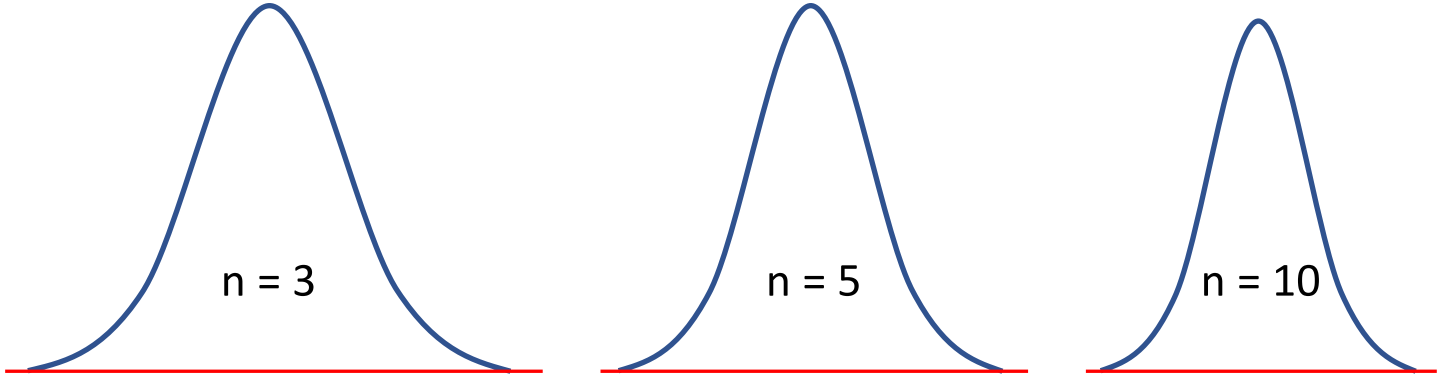
Table 2—Precision Estimates

Condition	Standard Deviation (1s)[a]	Acceptable Range of Two Test Results (d2s)[a]
Single-operator precision		
Asphalt binder content (%)	0.069	0.196
Multilaboratory precision		
Asphalt binder content (%)	0.117	0.330

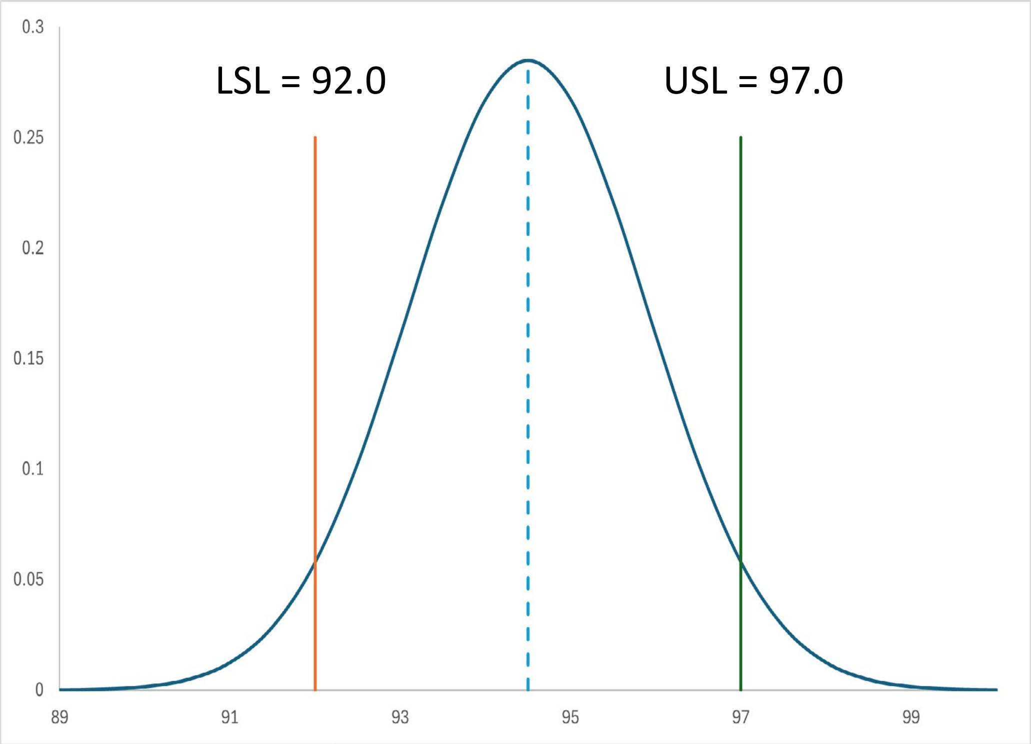
Sampling variability

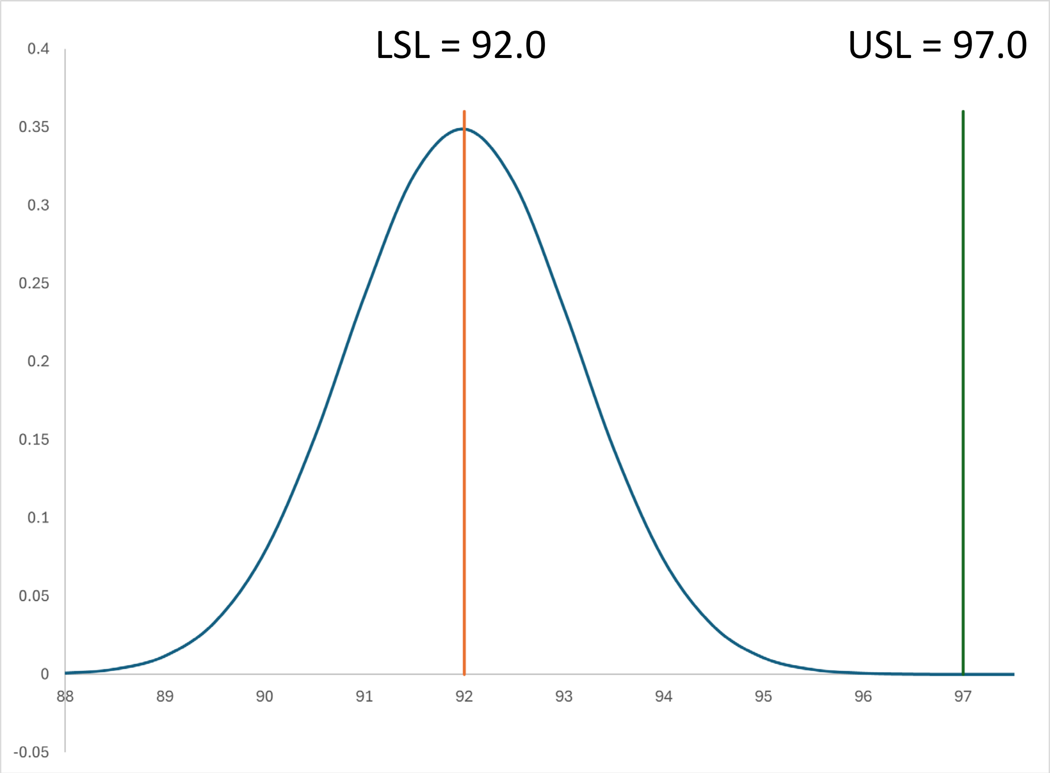
- Variability in physical sample collection
  - Location
  - Equipment
  - Personnel

- Variability inherent in sampling a population
  - Sample size affect



Evaluating sampling variability – Computer Simulation





Dataset 1
N = 10,000
Mean = 94.5%
s = 1.40
Actual PWL = 90

Dataset 2
N = 10,000
Mean = 92.0%
s = 1.40
Actual PWL = 50

Acceptance risk – 90 PWL

	n=3	n=5	n=10	n=20	n=30
Average Lot mean	94.5	94.5	94.5	94.5	94.5
Min. Lot mean	91.3	91.9	92.5	93.0	93.5
Max. Lot mean	98.1	97.4	96.4	95.9	95.5
Range of Lot means	6.8	5.5	3.9	2.9	2.0
Average Lot PWL	89.5	89.9	90.1	90.3	90.4
Min. Lot PWL	0	40	58	68	71
Max. Lot PWL	100	100	100	100	100
Probability of rejection	1.1%	0	0	0	0

Based on 10,000 replicates at each sample size

Acceptance risk – 50 PWL

	n=3	n=5	n=10	n=20	n=30
Average Lot mean	92.0	92.0	92.0	92.0	92.0
Min. Lot mean	88.7	89.2	90.1	90.8	91.1
Max. Lot mean	95.4	94.3	93.7	93.2	93.0
Range of Lot means	6.7	5.1	3.6	2.4	2.1
Average Lot PWL	50.3	50.8	50.8	50.7	50.8
Min. Lot PWL	0	0	1	14	25
Max. Lot PWL	100	100	98	82	77
Probability of acceptance	10.1%	2.8%	0.2%	0	0

Based on 10,000 replicates at each sample size

Payment risk – 90 PWL

	n=3	n=5	n=10	n=20	n=30
Actual Lot Pay Factor			1.00		
Average Lot Pay Factor	1.004	1.006	1.006	1.009	1.009
Min. Lot Pay Factor	0.55	0.77	0.84	0.885	0.915
Max. Lot Pay Factor	1.05	1.05	1.05	1.05	1.05
Pay Factor Range	0.50	0.28	0.21	0.16	0.14

PF = PWL X0.5 + 55

0 PWL = 0.55	50 PWL = 0.80	90 PWL = 1.00	**100 PWL = 1.05**

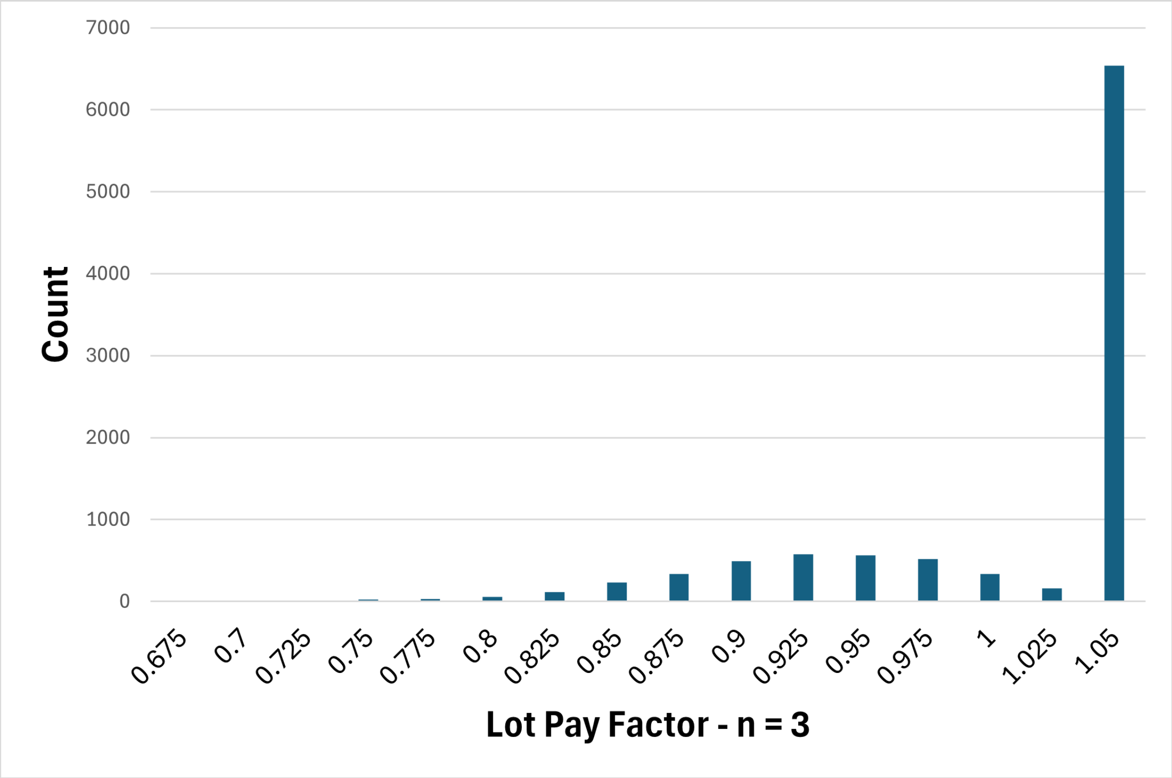
Payment risk – 50 PWL

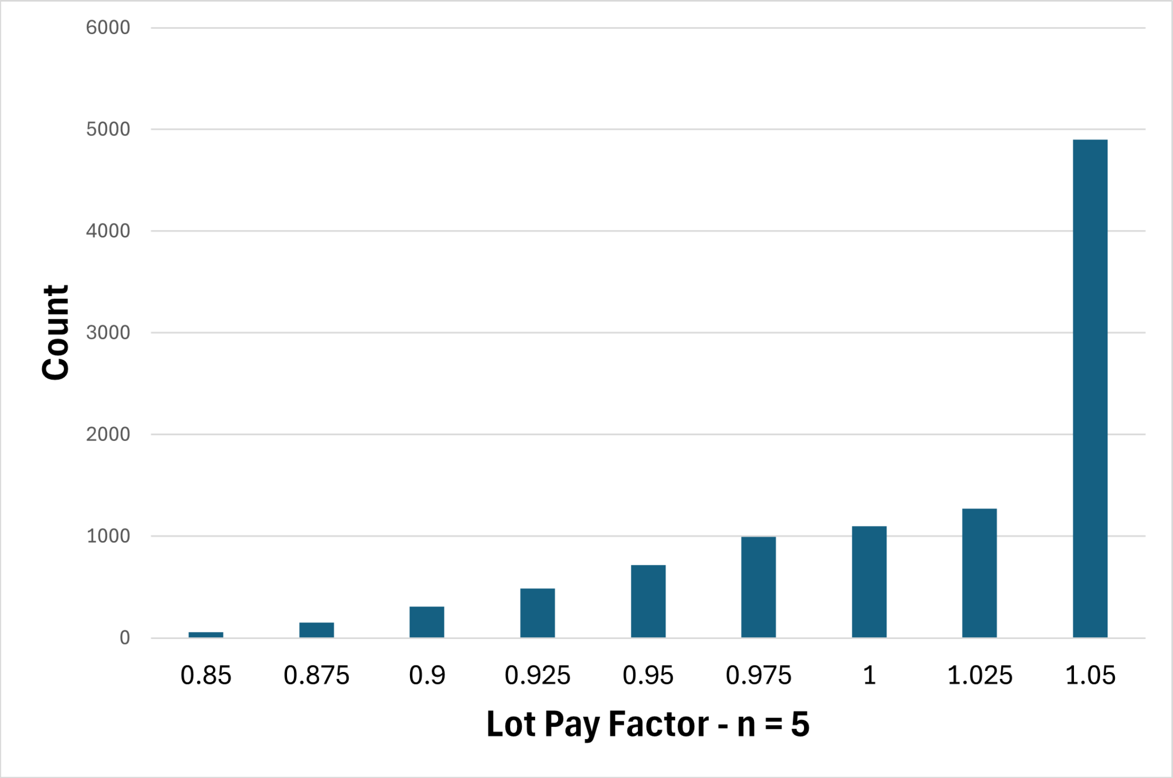
	n=3	n=5	n=10	n=20	n=30
Actual Lot Pay Factor			0.80		
Average Lot Pay Factor	0.801	0.804	0.803	0.804	0.803
Min. Lot Pay Factor	0.55	0.55	0.555	0.615	0.645
Max. Lot Pay Factor	1.05	1.05	1.045	0.965	0.94
Pay Factor Range	0.5	0.5	0.49	0.35	0.30

PF = PWL X0.5 + 55

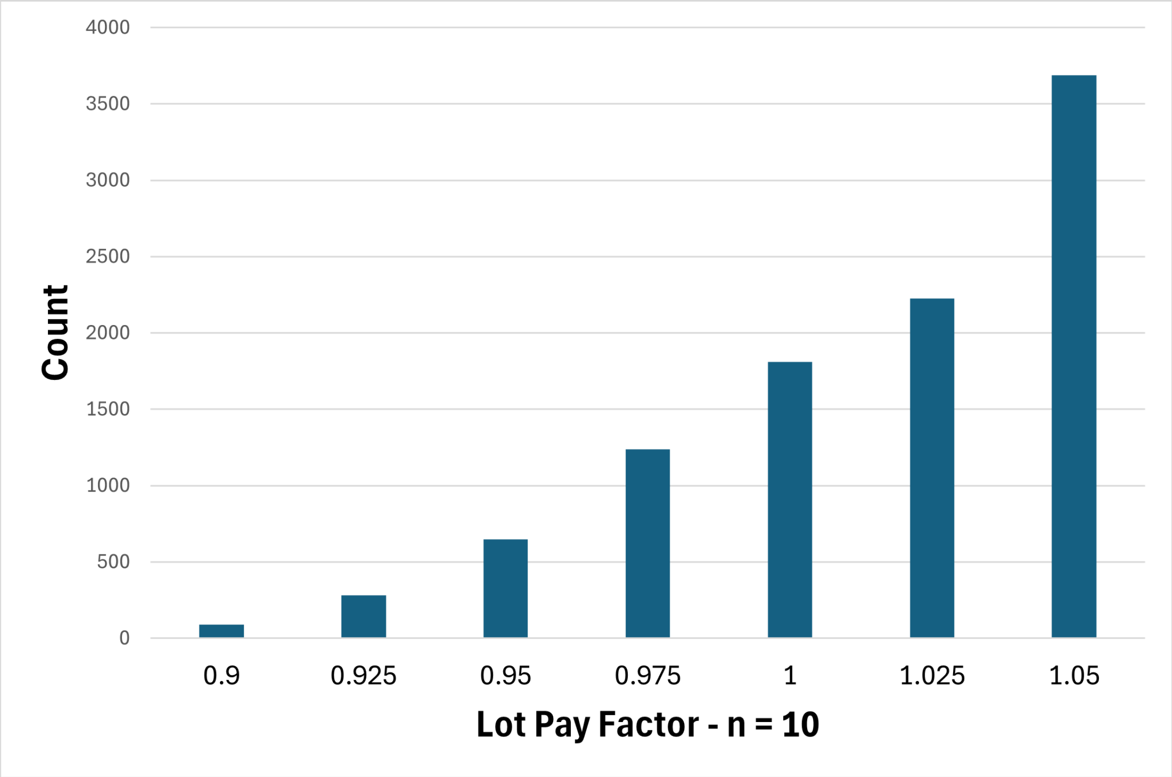
0 PWL = 0.55	50 PWL = 0.80	90 PWL = 1.00	**100 PWL = 1.05**

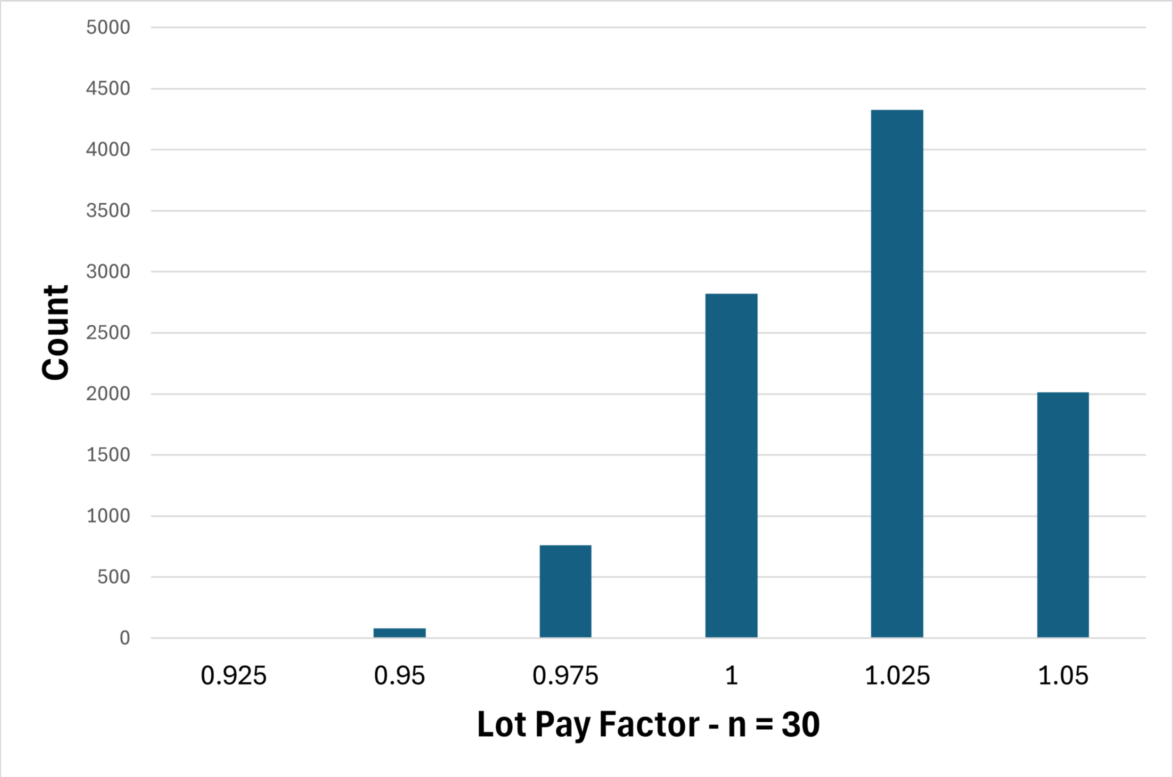
Pay Factor Distribution – 90 PWL



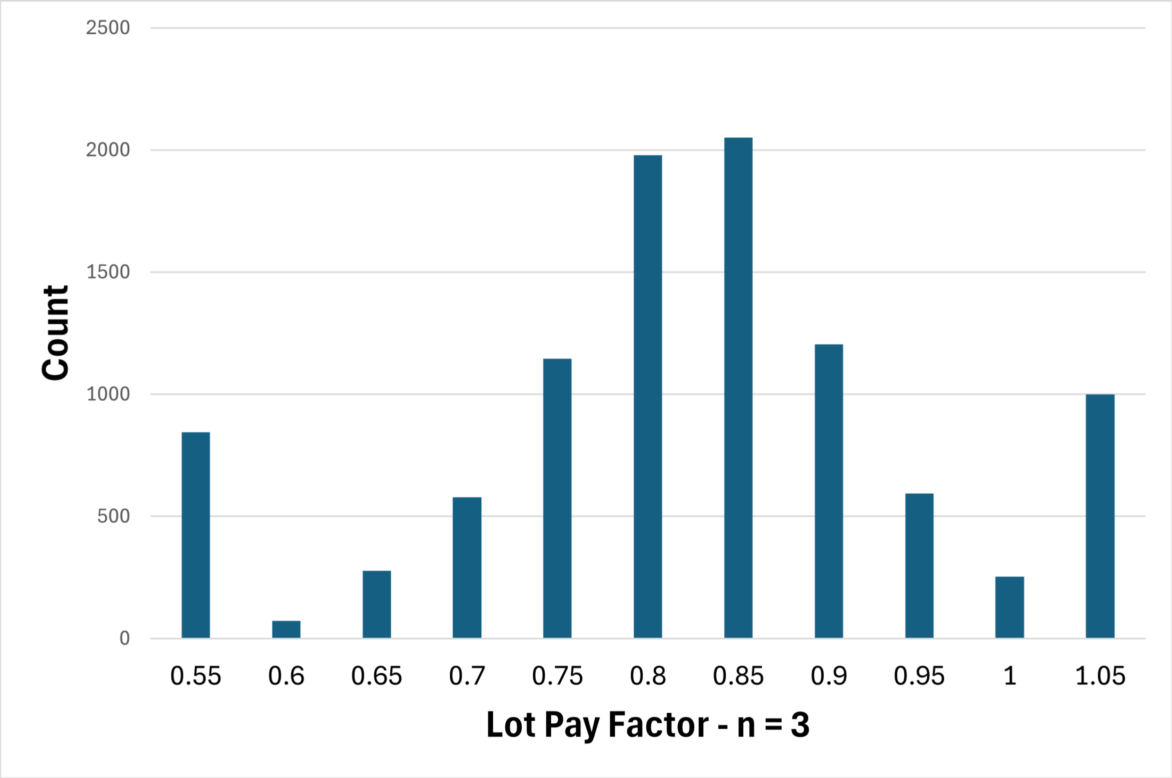


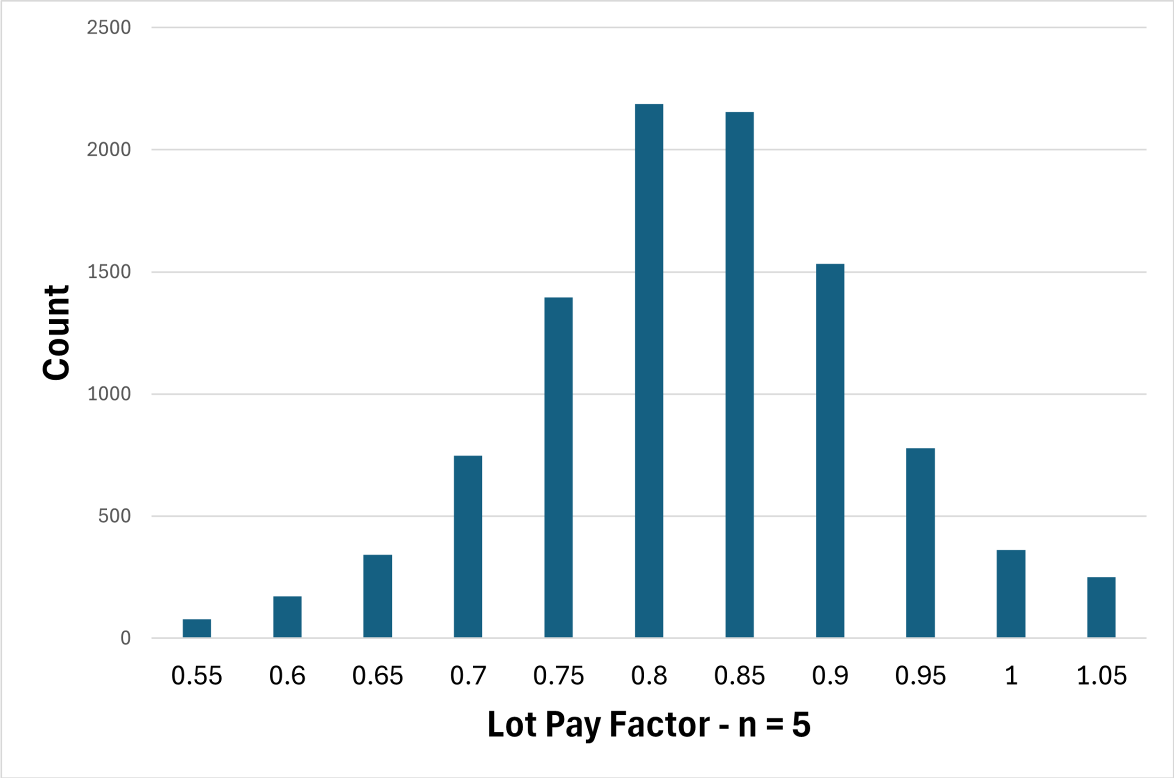
Pay Factor Distribution – 90 PWL



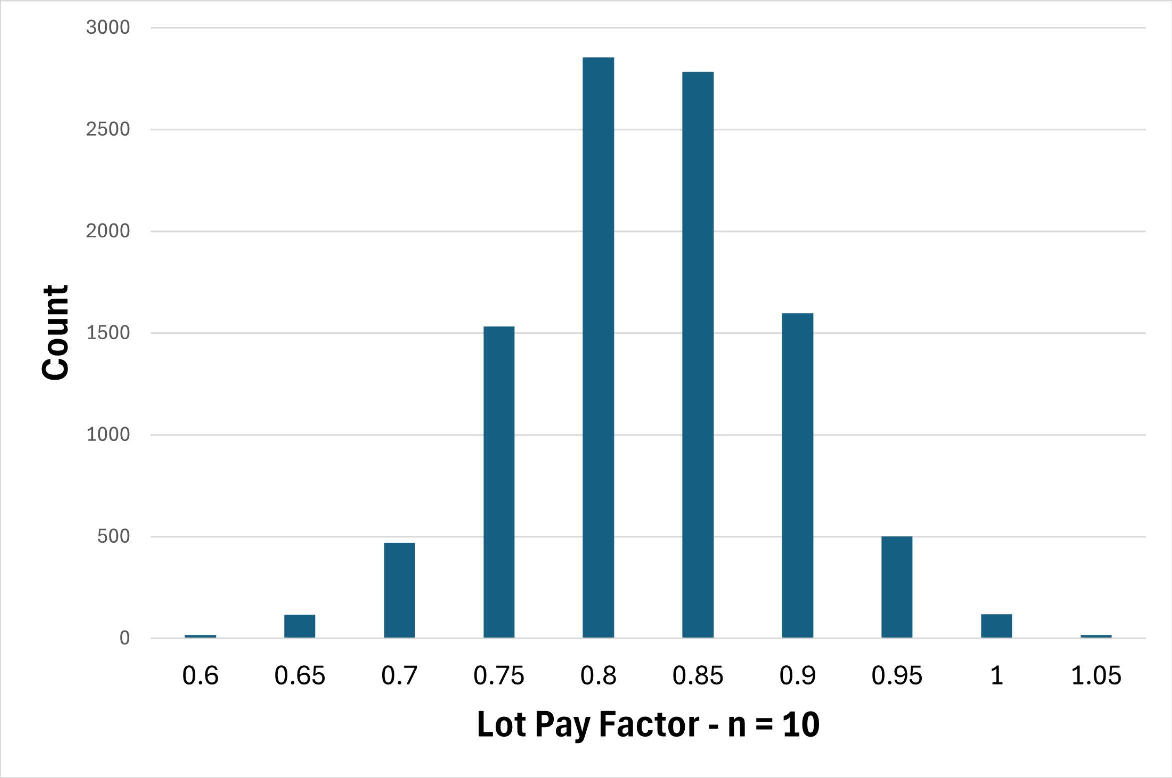


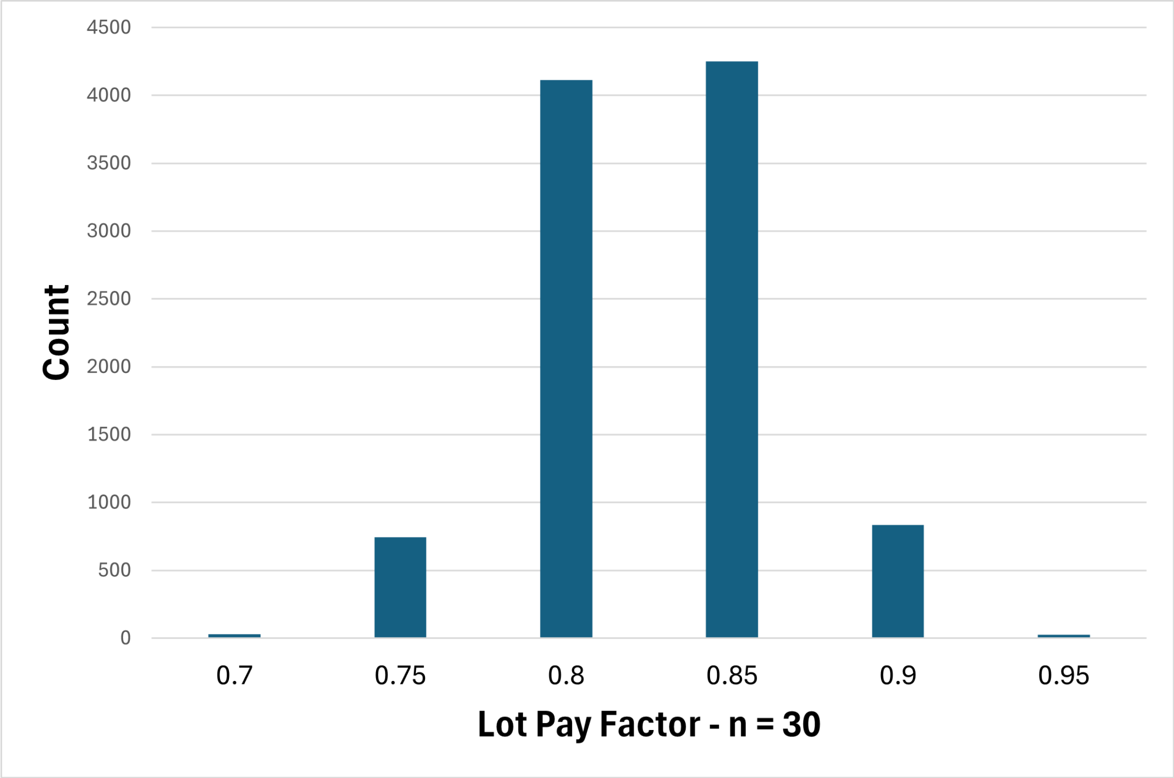
Pay Factor Distribution – 50 PWL





Pay Factor Distribution – 50 PWL





Reducing risk

- Increase sampling rate
  - Smaller sublot size
    - Balance sampling v. cost
    - Testing time (lab throughput)
  - Nondestructive tests
    - Large data sets
    - Rapid data collection
- Increase Lot size
  - Watch for process shifts

Questions?

- Contact info

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207-624-3482

Indicators for Material Certification and Testing Fraud

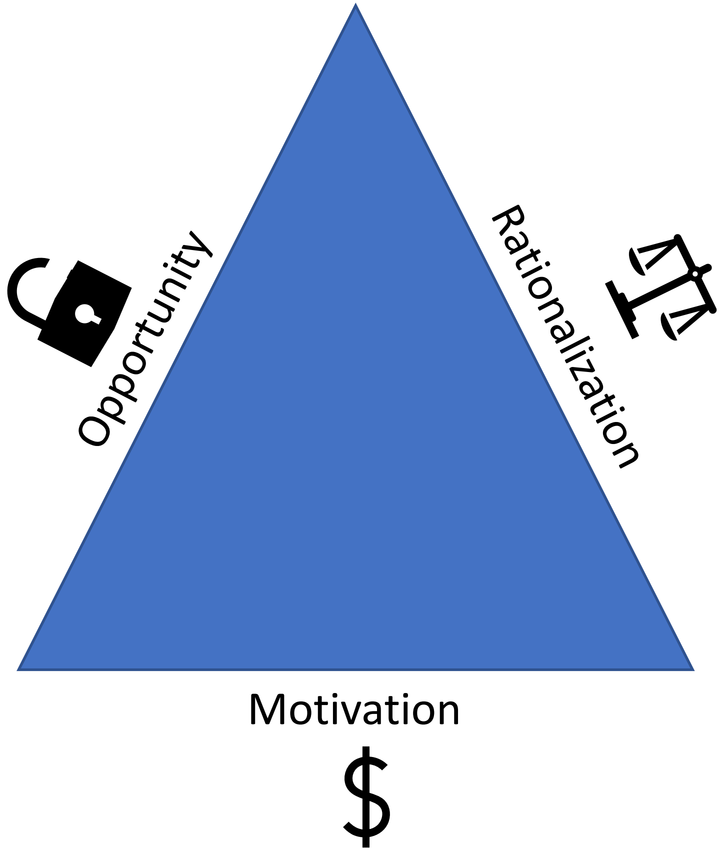
Mike Copeland

Construction & Materials Quality Program Manager

Idaho Transportation Department

Why Commit Fraud?

- **Opportunity:** Lack of oversight or weak controls.
- **Rationalization:** Justifying unethical behavior.
- **Motivation:** Pressure or incentive to commit fraud.



*Weak verification processes create **<u>opportunity</u>**, an incentive or need drives **<u>motivation</u>**, and **<u>rationalization</u>** justifies unethical actions.*

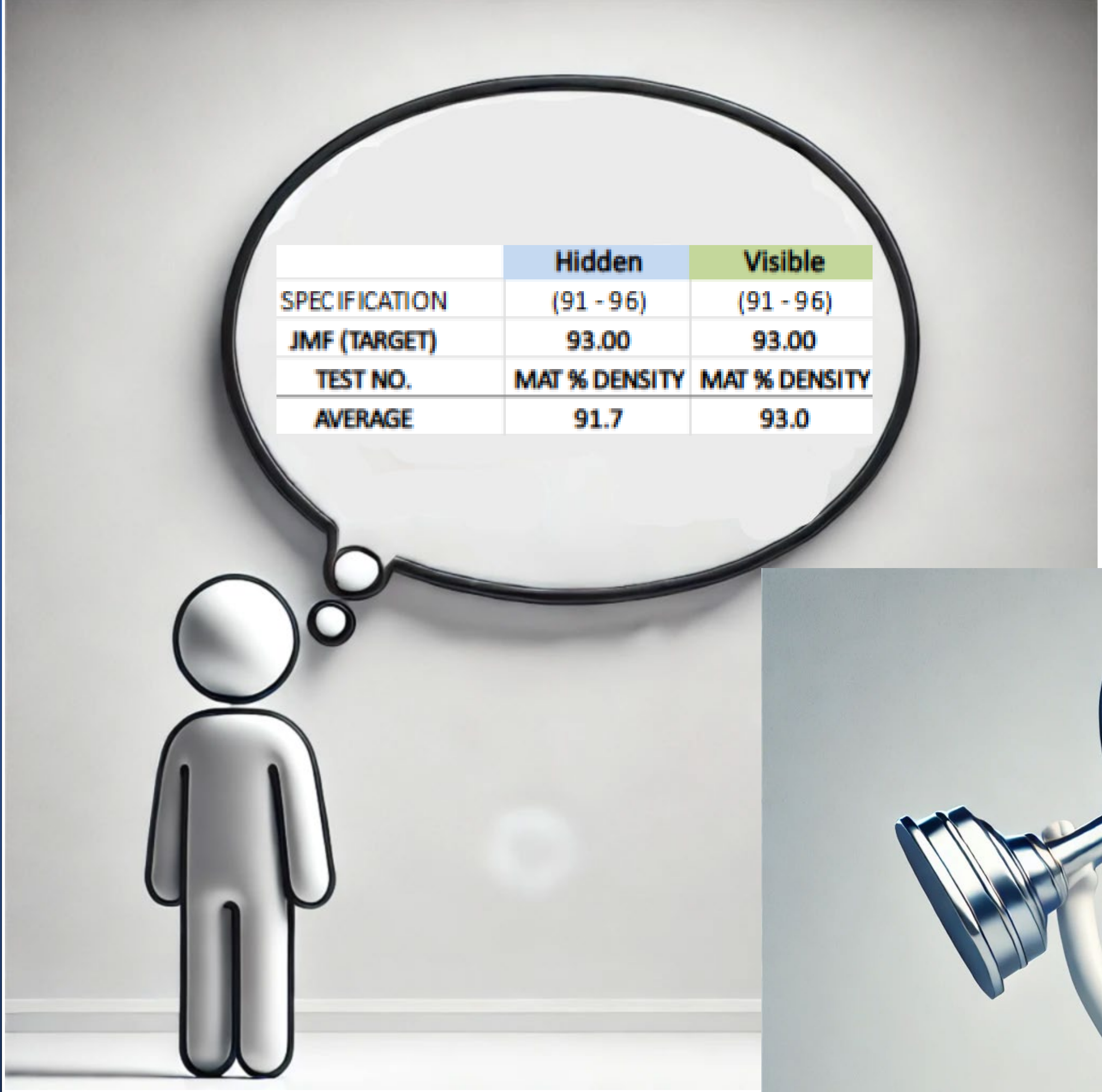
Opportunity

Motivation

Motivation


FINANCIAL PRESSURE
TIME PRESSURE
FRAUD
MOTIVATIOR
FRAUD MOTIVATORS
PRESSURE
FRAUD
MOTIVATORS
RATIONLIZATION

Motivation



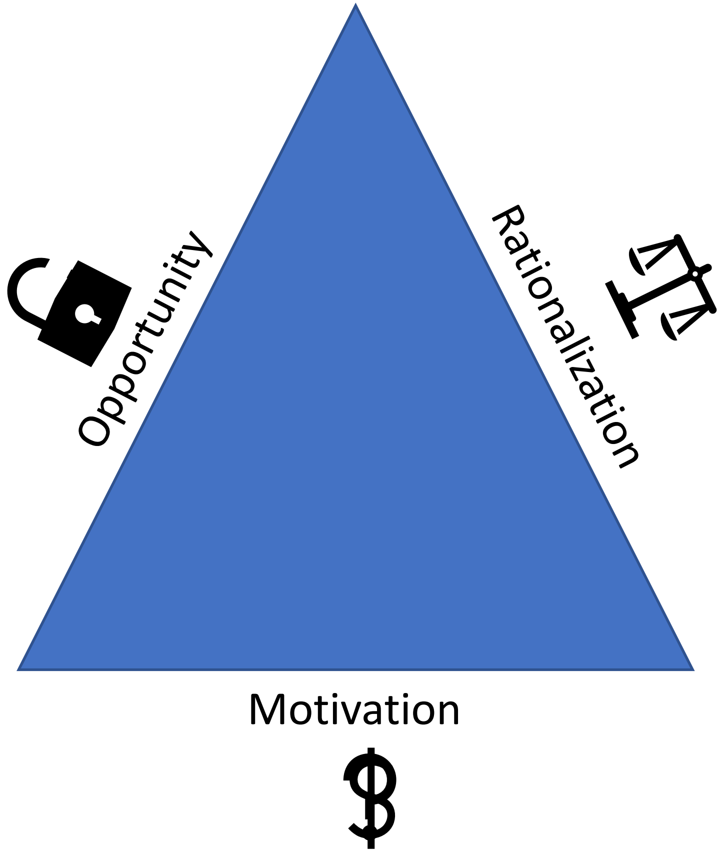
	Hidden	Visible
SPECIFICATION	(91 - 96)	(91 - 96)
JMF (TARGET)	93.00	93.00
TEST NO.	MAT % DENSITY	MAT % DENSITY
AVERAGE	91.7	93.0

Rationalization

What Would You Do?

Why Commit Fraud?

- **Opportunity:** Lack of oversight or weak controls.
- **Rationalization:** Justifying unethical behavior.
- **Motivation:** Pressure or incentive to commit fraud.



*Weak verification processes create **opportunity**, an incentive or need drives **motivation**, and **rationalization** justifies unethical actions.*

Traditional Fraud Prevention Practices

- Surprise Inspections
- Random Sampling
- Material Verification
- Documentation Rigor

Visual and Electronic Indicators

FOP for AASHTO T 166 Bulk Specific Gravity of Compacted Mix (Method A)			
Record to (0.1) Mass (g)	Dry Puck Mass (g)	Puck in Water Wt. (g)	Puck SSD Wt. (g)
Specimen 1	4705.7	2742.4	4710.1
Specimen 2	4705.0	2743.3	4711.4

FOP for AASHTO T 166 Bulk Specific Gravity of Compacted Mix (Method A)

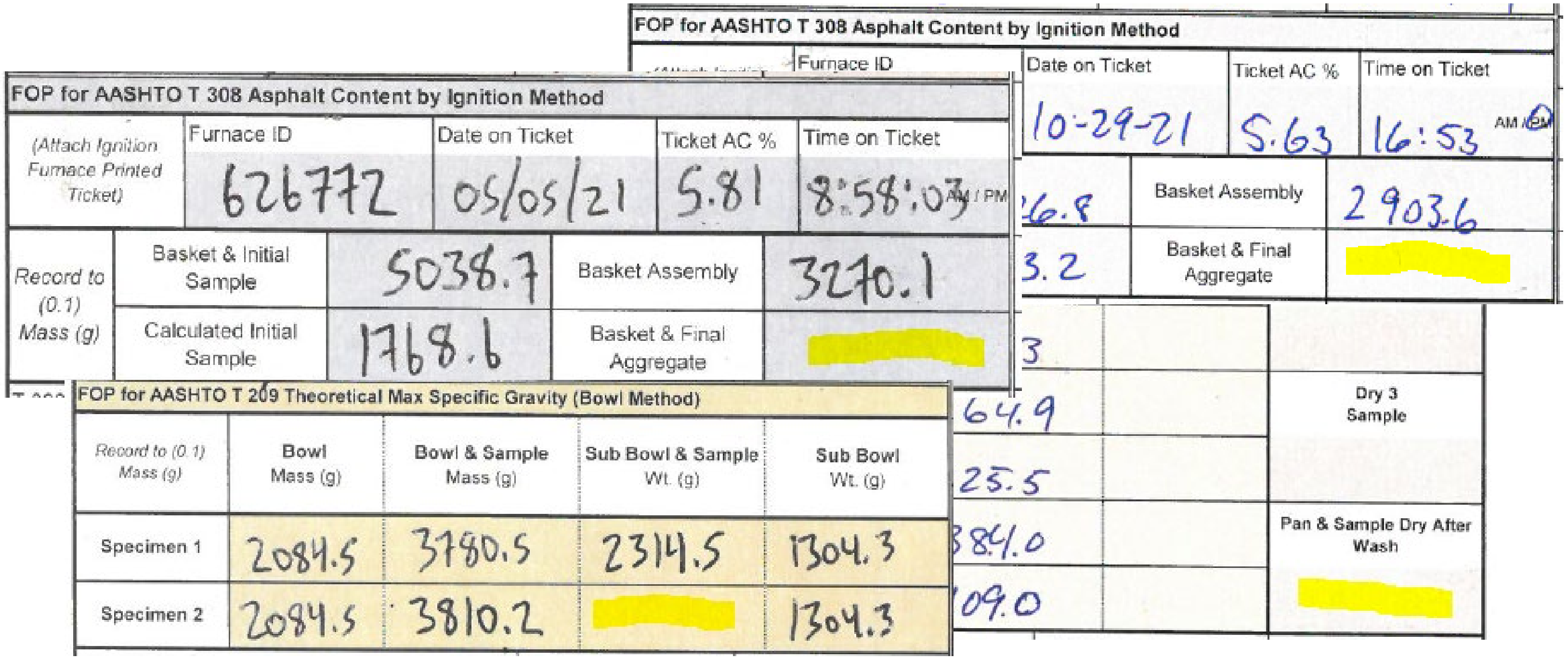
	Specimen 1	Specimen 2
Surface Temperature	75 *F	75 *F
Water Bath Temperature	77 *F	77 *F
Mass of Puck Dry (A)	4705.7	4705.0
Submerged Weight of Puck in Water (C)	2742.4	2743.3
Wt. of Puck SSD (B)	4710.1	4711.4
G_{mb} (Bulk Specific Gravity)	2.391	2.391
Average G_{mb}	**2.391**	

Range **0.001** (Within d2s precision?) **YES**

0.7

$$G_{mb} = \frac{A}{B - C}$$

Visual and Electronic Indicators



- Source documents missing key records.

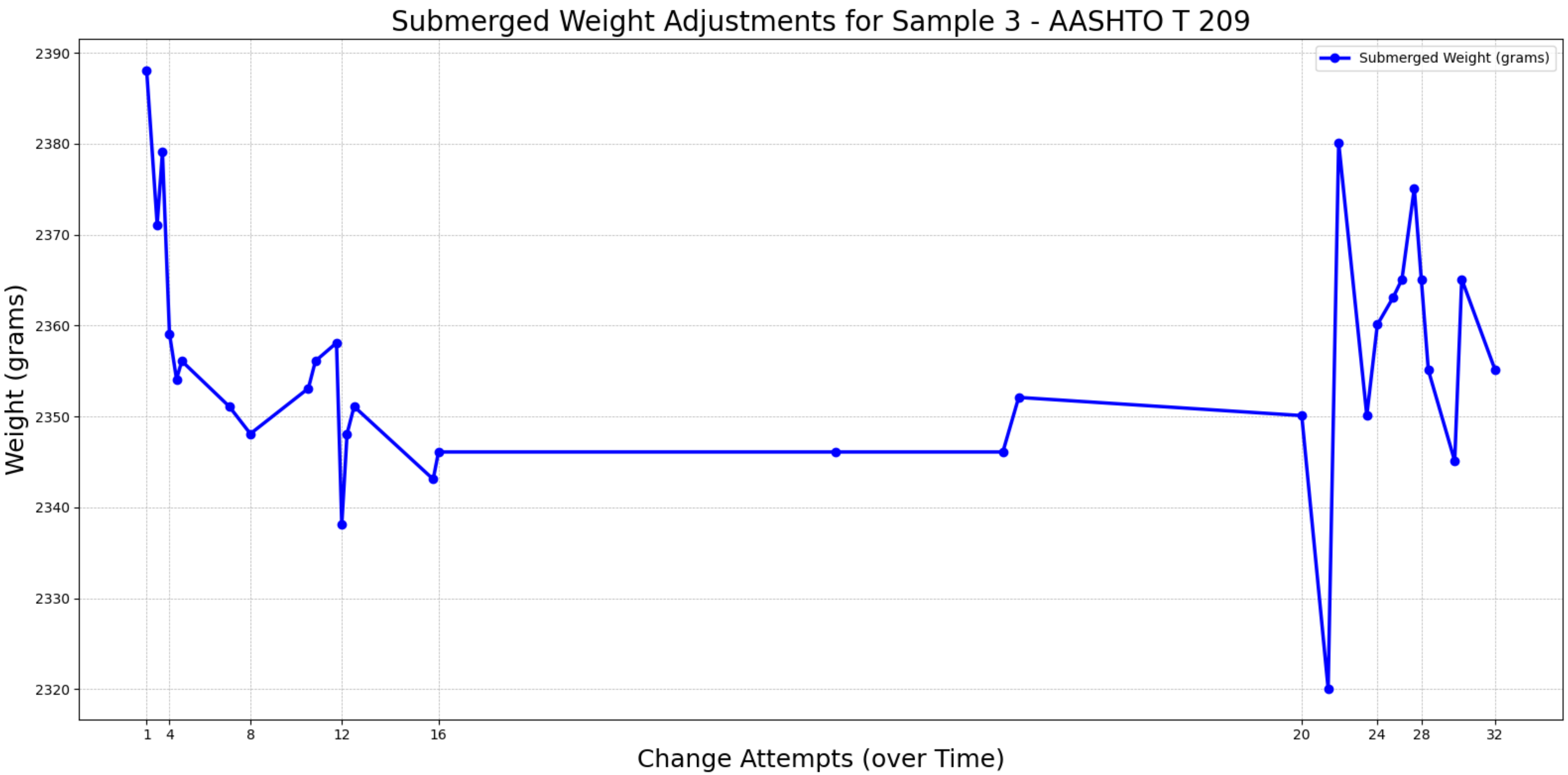
Visual and Electronic Indicators

- Different Fonts or layered images on PDFs
- Overwritten Information
- Handwritten and Typed
- Highlightable and Non-Highlightable Text
- Dates out of Order

Item(s) Description	Spec. References	Quantity
MILEPOST TY 1 (E-1 POSTS 2" x 2" x 12-ga.)	617.02, 708.16.2, 708.17	5-Each
BRKAWY STL SIGN POST TY E (E-1 POSTS 2.5" x 2.5" x 10-ga.)	616.02, 708.17,	200-lbs

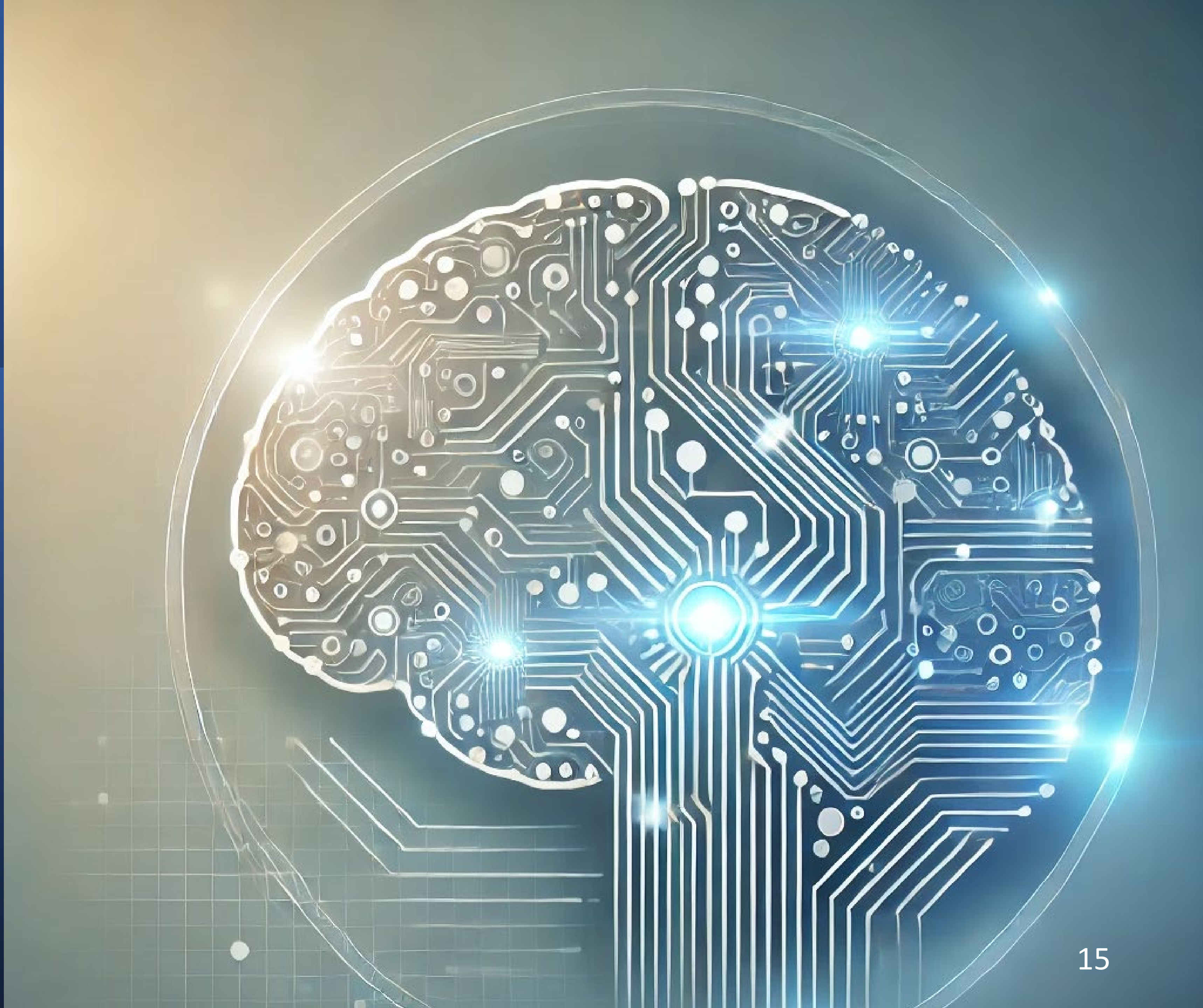
Supplier's Company Name	Address	
[redacted]	[redacted]	
Supplier's Authorized Representative's Name (Printed)	Supplier Representative's Signature	Date

The Power of Metadata in Detecting Fraud



This graph highlights how metadata captured a single submerged weight value entered 32 times in 25 minutes, showing patterns of trial-and-error adjustments.

Metadata and Artificial Intelligence



AI-Driven Solutions for Fraud Detection

- Real-time analysis
- Automated detection
- Scalable to 100% real-time review
- Reduced manual labor and errors

Item(s) Description	Spec. References	Quantity
MILEPOST TY 1 (E-1 POSTS 2" x 2" x 12-ga.)	617.02, 708.16.2, 708.17	5-Each
BRKAWY STL SIGN POST TY E (E-1 POSTS 2.5" x 2.5" x 10-ga.)	616.02, 708.17,	200-lbs

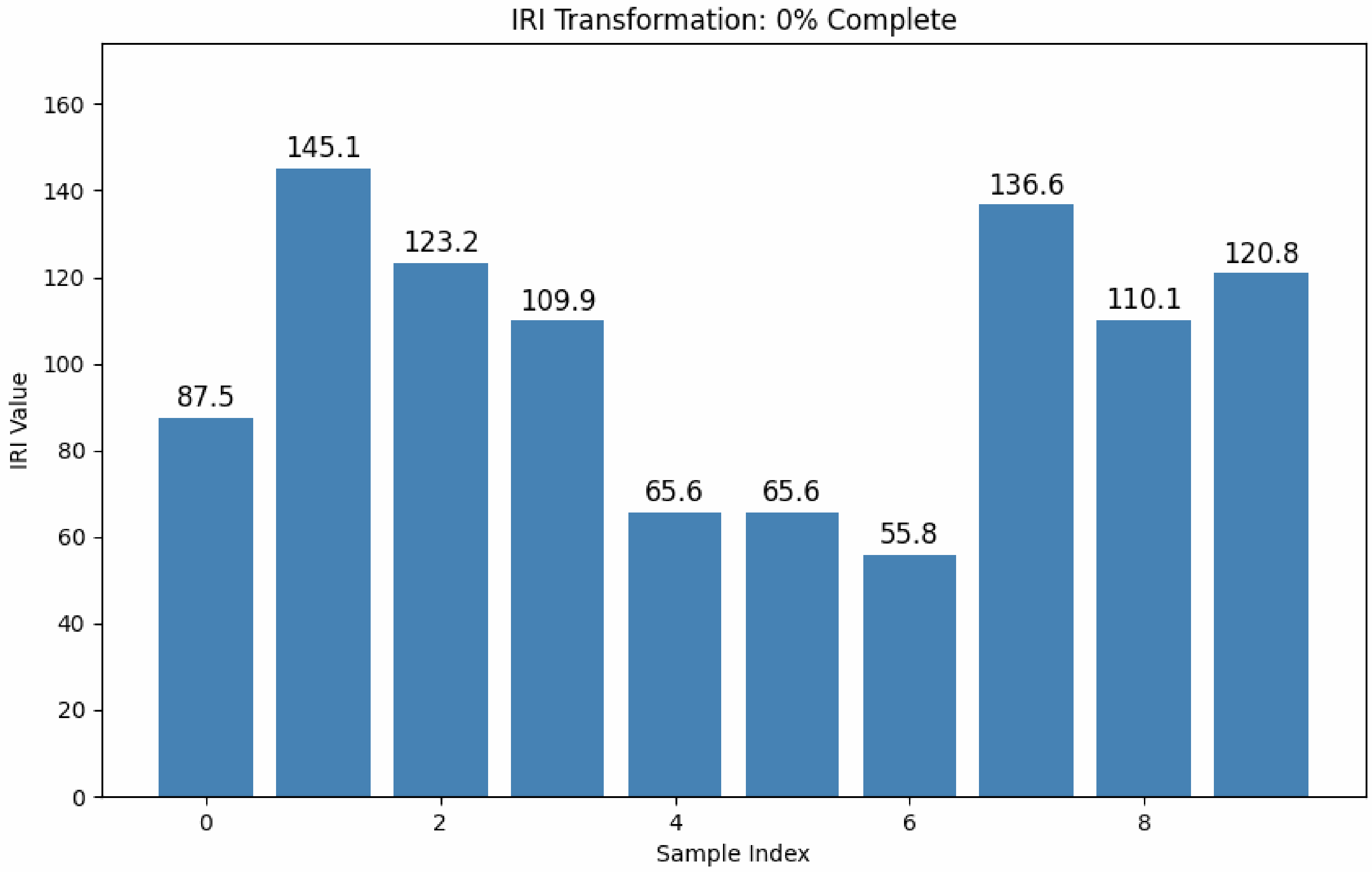
Emerging Risks: AI-Driven Data Manipulation and Fraud

Key Risks

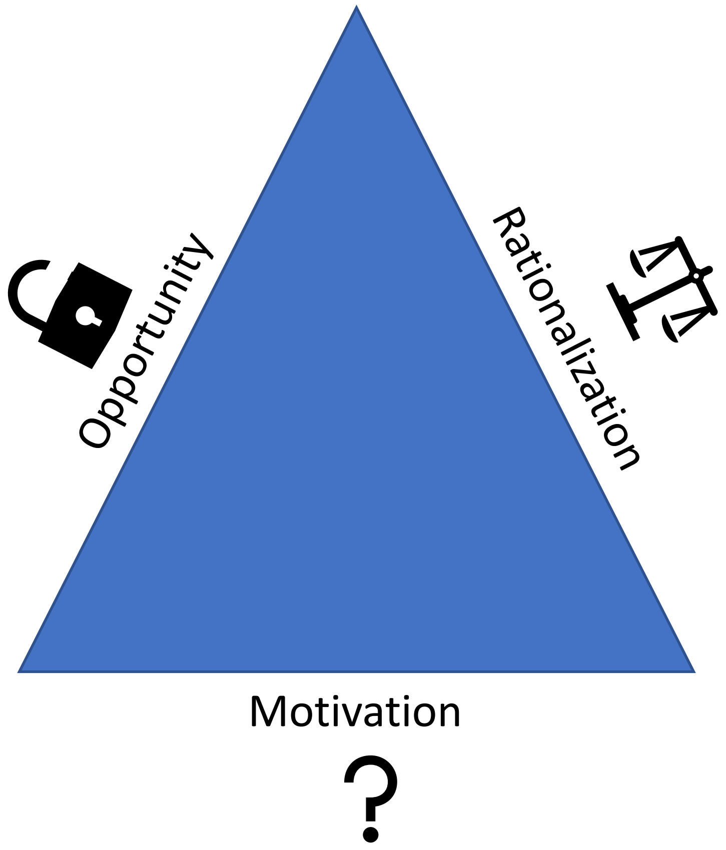
- Undetectable Tampering
- Automated Fraud at Scale
- Accessible Fraud Tools

Data Integrity at Risk

- Non-Programmer
- Less Than 2 Hours
- Testers Unaware
- Retained Metadata



Data Integrity at Risk



Conclusion

Key Takeaways

- Data Integrity Is Fundamental
- Fraud Is Driven by Human and Systemic Vulnerabilities
- AI Offers Powerful Solutions – But Also New Risks

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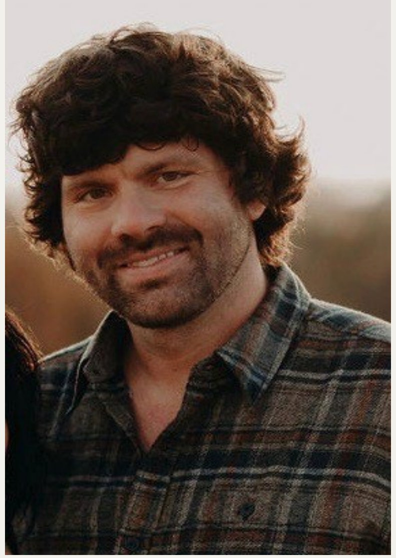

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February 25, 2025

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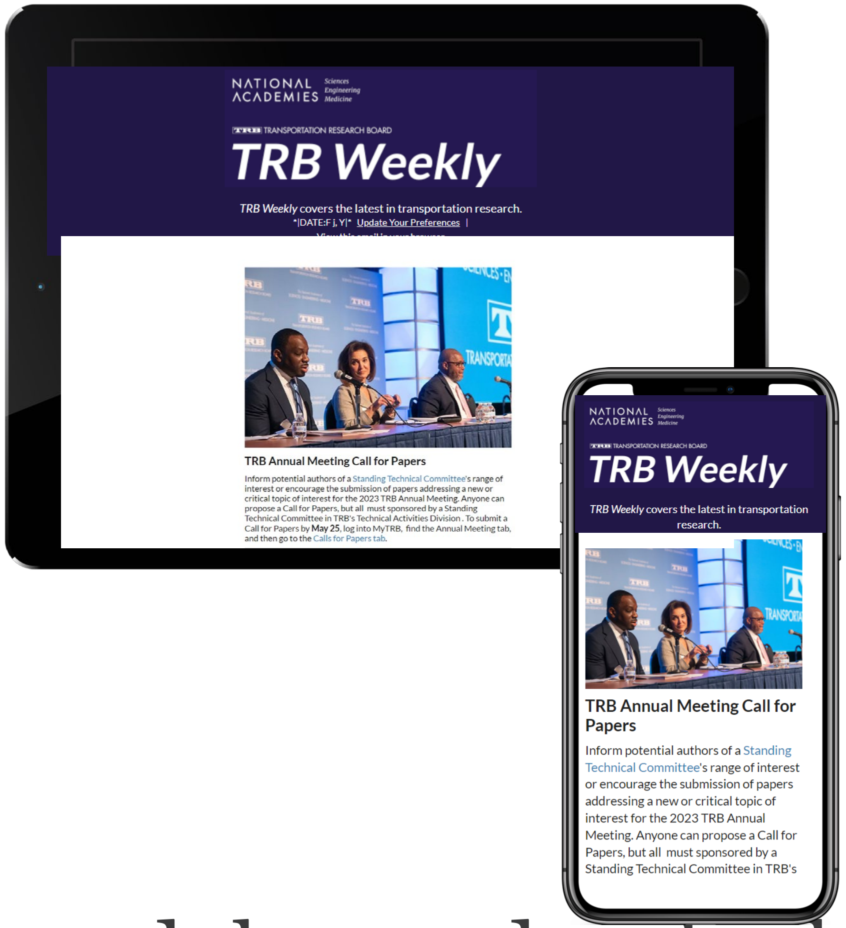

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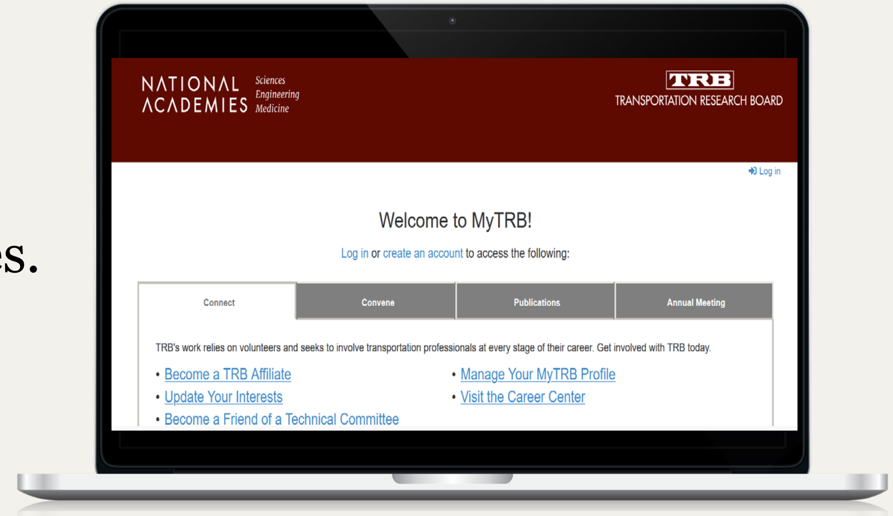

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