

Aggregate Testing Recertification

Quality Control / Quality Assurance



**DEPARTMENT OF
TRANSPORTATION**

****IMPORTANT****

Recertification is only for individuals currently certified and actively participating on Asphalt Concrete Projects (must attend certification class every 8 years)

DOT Employee Timesheet Information

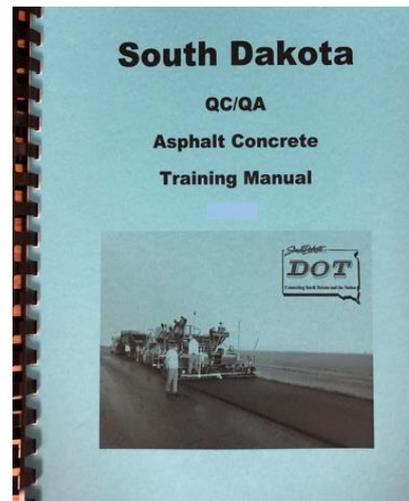
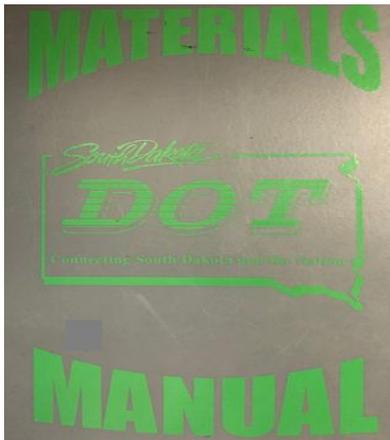
Charge to Office Overhead

AFE- 71B4

Function- 1174

Course Materials

- ▶ QC/QA Asphalt Concrete Training Manual
- ▶ Standard Specifications for Roads and Bridges
 - ▶ Supplemental Specifications
- ▶ South Dakota DOT Materials Manual
- ▶ Minimum Sample & Test Requirements



Course Agenda

- ▶ Sampling and Splitting
- ▶ Gradation
- ▶ Crushed Particles
- ▶ Sand Equivalent
- ▶ Fine Aggregate Angularity
- ▶ Lightweight Particles
- ▶ Specifications
- ▶ Construction Issues
- ▶ Recertification Exam

Asphalt Concrete Production Control

- ▶ Preconstruction meeting run by the Contractor
- ▶ Line of authority shown for both QC and QA personnel
- ▶ Certified testing personnel
- ▶ Calibrated test equipment
- ▶ Quality Control plan

Certification Requirements

- ▶ Testers must be QC/QA certified in SD
 - ▶ Must have proof of certification
- ▶ Testing equipment calibration records shall be available on National Highway System Projects.
- ▶ Certification requirements:
 - ▶ <https://dot.sd.gov/>

Certified Technicians

- ▶ Certified technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.

Laboratory Requirements

- ▶ Lab at plant site, Type III lab required for DOT personnel
- ▶ Ovens, power, etc.
- ▶ Calibration records in QC lab
 - ▶ All major equipment used for testing
 - ▶ Internal angle on gyratory compactor

Crushed Particles (SD 211)

- ▶ Used for determining % of pieces having one or more crushed faces.
- ▶ One crushed face: has a projected area of at least 25% of the max. cross-sectional area of the particle and the face has sharp and well-defined edges.
- ▶ Two crushed faces: the largest crushed face has a projected area of at least 50% of the max. cross-sectional area of the particle and the other crushed face has a projected area of at least 25% of the max. cross-sectional area of the particle and the faces have sharp and well-defined edges.



(Particles with one crushed face)



(Particles with two crushed faces)

Problem #1

Crushed Particles (SD 211)

- Using the data below, calculate the percentage of 2 or more crushed particles for the QC and QA lab.

Does the QC result meet the specification for a Q3 mix?

Do the test results meet the QC and QA tolerance for test result comparison?

	QC Test Result	QA Test Result
2 or more crushed particles weight (grams)	615.3	590.8
+ #4 Sample Wt. (grams)	750.1	787.4
% Crushed Particles	???	???

Problem #1 - Answer

Crushed Particles (SD 211)

- ▶ **QC:** $\left(\frac{615.3 \text{ grams}}{750.1 \text{ grams}}\right) \times 100 = 82 \%$
- ▶ **QA:** $\left(\frac{590.8 \text{ grams}}{787.4 \text{ grams}}\right) \times 100 = 75 \%$

	QC Test Result	QA Test Result
2 or more crushed particles weight (grams)	615.3	590.8
+ #4 Sample Wt. (grams)	750.1	787.4
% Crushed Particles	82	75

- ▶ Does the QC result meet the specification for a Q3 mix?
 - ▶ (Answer) : Yes (75 % min) [Spec. Book Section 322]
- ▶ Do the test results meet the QC and QA tolerance?
 - ▶ (Answer): Yes ($\pm 10\%$) [Materials Manual - R.S.T.C.]

Mix Design Report

- ▶ Approved Mix Design Report
- ▶ Posted in both QC and QA lab
- ▶ Includes:
 - ▶ Mix compaction temperatures
 - ▶ Job Mix Formula
 - ▶ Gyratory, Rice, & other Mix Design results
 - ▶ Aggregate moisture content at SSD
 - ▶ Aggregate Composite Gsb, aggr. comp. -#4 Gsb
 - ▶ Aggregate Composite % H₂O at SSD if lime is added

REPORT ON AGGREGATE RETINUES MATERIAL PROPORTIONS
SOUTH DAKOTA DOT BETHBURG & MCKENNA LAB
1048 GARDINER BLVD. B. PIERRE, SD

Project: N818085028 County: Butte, Harding DOT 64
PCN: 64WE Reported: 12-Sep-18
Job Location: US85 South of Rt 640/Butte Co. line South - 21.370 Miles
Sample Submitted By: Western Construction App. Sub: 25-Aug-18 at 04:56:01 01-Sep-18
Aggregate Source: Flag House PI, Rt 177 TENNES. Minn. Co. H&S RC Query
Catcher To: SCDOT TEN. Minn. Co.
Type of Work: Asphalt Concrete Resurfacing Class OMR
Normal Agg. Size: 1.25 mm

Prime Contractor: Bader Signs Printing Inc.

GRADATION OF GENERAL AGGREGATE USED FOR TRIAL MIXTURES

Sieve	Gradation (Accumulative Percentages Passing)										Contractor	Virgin
	% Total	25	25	10	10	5	5	20	20	20		
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
3/4 IN.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5/8 IN.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.5	99.5	96	85-100
1/2 IN.	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	91.1	91.1	84	77-91
3/8 IN.	45.0	100.0	100.0	100.0	100.0	100.0	100.0	94.9	84.9	84.9	74	67-81
#4	5.0	95.0	95.0	95.0	85.0	95.0	95.0	85.7	75.7	75.7	64	57-81
#10	2.0	57.0	57.0	57.0	54.0	57.0	57.0	57.8	42.1	42.1	42	37-47
#20	1.6	30.2	30.2	30.2	28.2	30.2	30.2	30.2	23.1	23.1	20	17-23
#30	1.7	16.0	16.0	16.0	15.0	16.0	16.0	16.0	12.1	12.1	10	9-12
#50	1.6	9.9	9.9	9.9	9.8	9.9	9.9	9.9	7.1	7.1	6	5-7
#200	1.6	7.5	7.5	7.5	7.1	7.5	7.5	7.5	5.4	5.4	4.4	2.4-5.4

Virgin Binder by weight of total mix = 3.5 per cent Peak PG 58-34
Total Binder by wt. of total mix (minimum) = 5.0 per cent
Minimum Limit by weight of total mix = 5.0 per cent
* Total binder content is calculated using 2.5 % for RAP & % RAP from daily test (rounded) added to Virgin Binder content.
example: (7.50 x .85) + (.45) (1.0) + (.10) = 6.50 % (5.1 % rounded) Total Binder for this job (RAP & Virgin) = 6.50 %
Contractor Mix Design Verification at 100%: 100% Virgin 58 34
SD DOT MIX LAB 2383 2485 5.0 15.0 1.0 0.1 45.0 88
CONTRACTOR LAB 2328 2482 5.8 14.0 1.1 1.1 45.1 91

Fish Tapes Air Void Level: 1.5% Aggregate Moisture Content at SSD: 1.8%

Temperature of mixture when sampled from the drum: 295 ± 20 °F
Temperature of mixture on delivery to the road: 285 ± 20 °F App. Composite Gsb
Asphalt application temperature at the mixer: 300 ± 20 °F 2.627 (Average Results)
Contractor compaction temperature: 275 ± 0 °F 2.619 (Average Results)

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Submitted: *James J. Coshell*
James J. Coshell
Sr. Mix Design Engineer

Reviewed: *Richard E. Reeves*
Richard E. Reeves
District Engineer

Aggregate Cold Feed Sample

- ▶ Calibration test on cold feed sample ran by QC and QA testers
- ▶ Sample obtained from cold feed belt (SD 201)
- ▶ Sample size (Gyratory):
 - ▶ Enough to have 4 splits (6 if IA sample required)
 - ▶ Large enough to do all required tests
- ▶ Splitting (SD 213)
- ▶ Frequency of needed tests:
 - ▶ QC: 1 every 1,000 tons
 - ▶ QA: min. 1 per 5,000 tons
 - ▶ IA: 1 per 15,000 tons

What is the sample retention time for Gyratory samples?

- ▶ For QC:

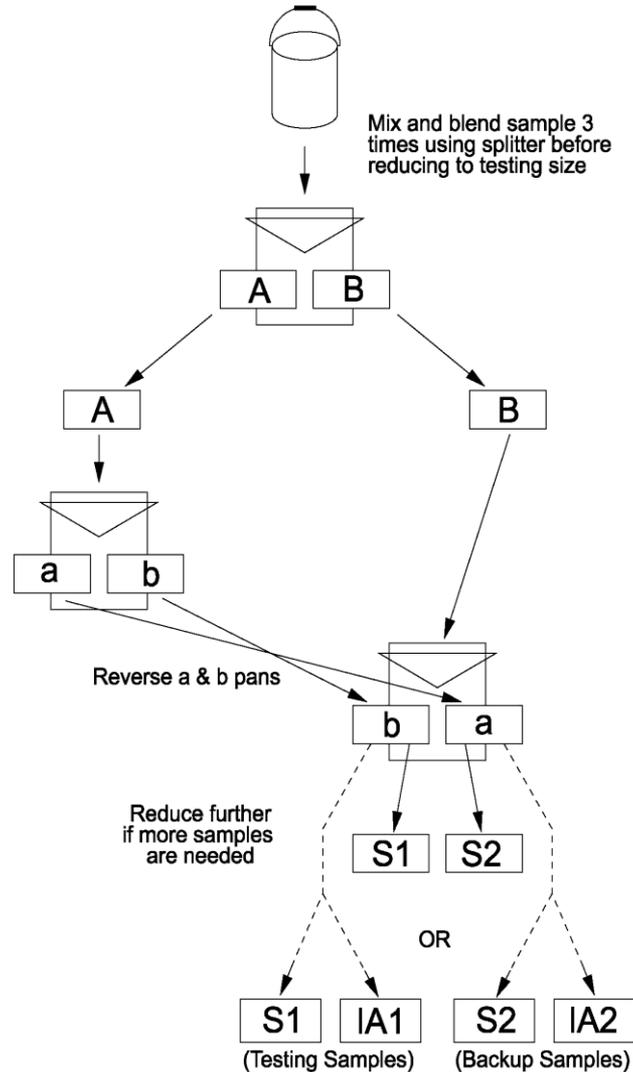
- ▶ Until IA and QA tests completed and Engineer approves disposal

- ▶ For QA:

- ▶ Until the Bituminous Engineer has completed the F-test and t-test statistical evaluation

Splitting Procedure

► Read Procedure in SD 213



Gradation (SD 202)

- ▶ Nominal Maximum Size: the smallest sieve opening, through which 90% or more of the sample being tested will pass.
- ▶ Bin splits shown on the DOT-3
- ▶ Moisture Percentage
- ▶ Dust Check, total combined - #200
- ▶ + #4 and - # 4 gradation check
- ▶ Adequacy of sieving
 - ▶ Not more than 0.5% by weight of the original dry sample weight on a sieve shall pass that sieve in one minute of hand sieving.
- ▶ Check for overloaded sieves
 - ▶ Chart in SD 202
- ▶ JMF specification compliance
- ▶ **Example Problem #2**



Problem #2

Total Combined - #200

Calculate the total combined - # 200

- ▶ The coarse sieve analysis had 70.7% passing the #4 sieve.
- ▶ The washed coarse aggregate sample had 0.64 % passing the #200 sieve.
- ▶ 5.01% passed the #200 sieve on the fine sieve analysis.

Coarse	_____	x	% Retained/Design	_____	=	_____
Fine	_____	x	% Passing/Design	_____	=	_____
			Total Combined - #200		=	_____

Problem #2 - Answer

Total Combined - #200

Calculate the total combined - # 200

- ▶ The coarse sieve analysis had 70.7% passing the #4 sieve.
- ▶ The washed coarse aggregate sample had 0.64 % passing the #200 sieve.
- ▶ 5.01% passed the #200 sieve on the fine sieve analysis.
- ▶ % Retained/Design = $100 - \% \text{ Passing(Design)} = 100 - 70.7 = 29.3 \%$

$$\frac{0.64 \times 29.3}{100} = 0.19$$

$$\frac{5.01 \times 70.7}{100} = 3.54$$

$$0.19 + 3.54 = 3.73 \text{ or } 3.7 \%$$

Coarse	<u>0.64</u>	x	% Retained/Design	<u>29.3</u>	=	<u>0.19</u>
Fine	<u>5.01</u>	x	% Passing/Design	<u>70.7</u>	=	<u>3.54</u>
Total Combined - #200					=	<u>3.7</u>

Sand Equivalent (SD 221)

- ▶ Reference AASHTO T 176
- ▶ Obtain sample from moistened material which a cast can be formed without free water
- ▶ Dry before testing
- ▶ Stock solution is good for how long?
 - ▶ Working solution more than 30 days old shall be discarded.
- ▶ Example Problem #3

Problem #3 - Answer

Sand Equivalent

Class Q3

Sand Equiv Test	Sand Rdg.	Clay Rdg.	S. E.
Reading # 1	3.2	4.4	73
Reading #2	3.2	4.5	72
Sand Equivalent Test Results			73

45% Min.
Spec.

$$S. E. = \left(\frac{\text{Sand Rdg. \#1}}{\text{Clay Rdg. \#1}} \right) \times 100 = \left(\frac{3.2}{4.4} \right) \times 100 = 72.7 \text{ (* always round up)} = \mathbf{73}$$

$$S. E. = \left(\frac{\text{Sand Rdg. \#2}}{\text{Clay Rdg. \#2}} \right) \times 100 = \left(\frac{3.2}{4.5} \right) \times 100 = 71.1 \text{ (*always round up)} = \mathbf{72}$$

Average the Results

Specification: Spec. Book Sect. 322 (Class Q3)

Fine Aggregate Angularity (SD 217)

- ▶ Reference AASHTO T 304
- ▶ Calibrated cylinder
- ▶ Sample obtained from material retained on #16, #30, #50 and #100 sieve sizes

Passing the #8 and retained on the #16 =	44 grams
Passing the #16 and retained on the #30 =	57 grams
Passing the #30 and retained on the #50 =	72 grams
Passing the #50 and retained on the #100 =	<u>17 grams</u>
Total =	190 grams

The tolerance for the sample is ± 0.2 grams per sieve.

- ▶ What do you do if it fails?
 - ▶ Cease operations, take corrective action and get a passing sample
- ▶ **Example Problem #5**



Problem #4

Fine Aggregate Angularity

Class Q2R, Fill in the blanks and Calculate FAA. What is the spec?

Fine Aggregate Angularity

SD 217

Method A

$$V = 1000 M/D$$

Weight of measure and glass plate
 weight of measure, glass plate & water
 M = net mass of water
 D = density of water at test temp.
 V = volume of cylinder, mL

284.8
385.6
997.97

Temperature ° F	° C	Density of Water	
		lb/ft ³	kg/m ³
60	15.6	62.366	999.01
65	18.3	62.336	998.54
70	21.1	62.301	997.97
75	23.9	62.261	997.32
80	26.7	62.216	996.59
85	29.4	62.166	995.83

From Job Mix Formula
Aggr -#4 Gsb

Sample ID	1st trial	2nd trial	
Dry -#4 bulk specific gravity (Gsb)	2.591	2.591	
Volume of cylinder, mL (V)			
Weight of cylinder, g (A)	247.5	247.5	
Wt. of cylinder + aggregate, g (B)	399.3	399.4	
Wt. of aggregate, g (F = B - A)			
Uncompacted voids, (nearest 0.1%) U = ((V - (F / Gsb)) / V) * 100			Average

Problem #4 - Answer

Fine Aggregate Angularity

- ▶ M (net mass of water) = $385.6 - 284.8 = 100.8$
- ▶ V (volume of cylinder, mL) = $1000 \times \left(\frac{M}{D}\right) = 1000 \times \left(\frac{100.8}{997.97}\right) = 101.0$
- ▶ F_1 (wt. of aggregate, g) = $399.3 - 247.5 = 151.8$
- ▶ F_2 (wt. of aggregate, g) = $399.4 - 247.5 = 151.9$

- ▶ U_1 (uncompacted voids) = $\frac{V - \left(\frac{F}{G_{sb}}\right)}{V} \times 100 = \frac{101.0 - \left(\frac{151.8}{2.591}\right)}{101.0} \times 100 = 42.0$
- ▶ U_2 (uncompacted voids) = $\frac{V - \left(\frac{F}{G_{sb}}\right)}{V} \times 100 = \frac{101.0 - \left(\frac{151.9}{2.591}\right)}{101.0} \times 100 = 42.0$
- ▶ **Specification**
 - ▶ Spec. Book Sect. 322 (Class Q2R)
 - ▶ **Minimum 41.5 %**

Problem #4 - Answer

Fine Aggregate Angularity

Class Q2R Spec: Min. 41.5%

Fine Aggregate Angularity

SD 217

Method A

$$V = 1000 M/D$$

Weight of measure and glass plate
 weight of measure, glass plate & water
 M = net mass of water
 D = density of water at test temp.
 V = volume of cylinder, mL

Weight of measure and glass plate	284.8
Weight of measure, glass plate & water	385.6
M = net mass of water	100.8
D = density of water at test temp.	997.97
V = volume of cylinder, mL	101.0

Temperature		Density of Water	
⁰ F	⁰ C	lb/ft ³	kg/m ³
60	15.6	62.366	999.01
65	18.3	62.336	998.54
70	21.1	62.301	997.97
75	23.9	62.261	997.32
80	26.7	62.216	996.59
85	29.4	62.166	995.83

Sample ID	1st trial	2nd trial	
Dry -#4 bulk specific gravity (Gsb)	2.591	2.591	
Volume of cylinder, mL (V)	101.0	101.0	
Weight of cylinder, g (A)	247.5	247.5	
Wt. of cylinder + aggregate, g (B)	399.3	399.4	
Wt. of aggregate, g (F = B - A)	151.8	151.9	Average
Uncompacted voids, (nearest 0.1%) U = ((V - (F / Gsb)) / V) * 100	42.0	42.0	42.0

- #4 Lightweight Particles (SD 208)

- ▶ 250 to 350 gram sample
- ▶ Previously washed material may not be used
- ▶ Screen material on a #30 sieve
- ▶ Zinc chloride solution with a specific gravity of 1.95 ± 0.01



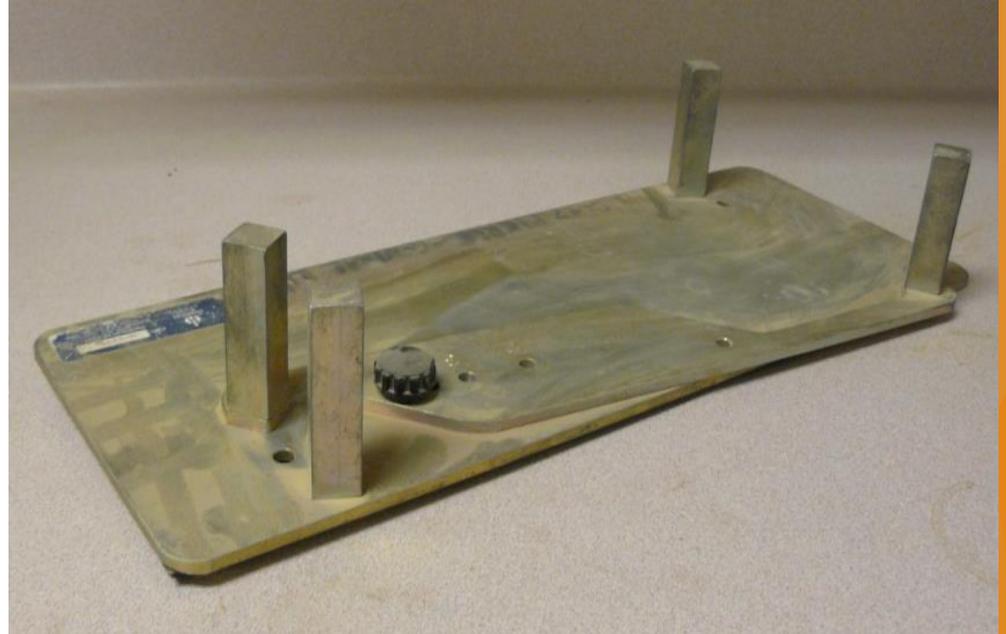
+ #4 Lightweight Particles (SD 214)

- ▶ 1500 to 2000 gram sample
- ▶ Previously washed material may not be used
- ▶ Zinc chloride solution with a specific gravity of 1.95 ± 0.01



Flat and Elongated Particles (SD 212)

- ▶ Now only on mix design sample & production control
- ▶ Reference ASTM D 4791



Specification Compliance

- ▶ QA test results compared to QC test results.
- ▶ IA test results compared to QC and QA test results.
- ▶ Similar/Dissimilar (SD 317)
- ▶ F and t test

QC, QA and IA

Sample and Test ID

- ▶ For Quality Control, use the prefix “QC”
 - ▶ Example: QC01, QC02, QC03...
- ▶ For Quality Assurance, use the prefix “QA” and the related QC test number
 - ▶ Example: QA01/QC01, QA02/QC06, QA03/QC14...
- ▶ For Independent Assurance, use the prefix “IA” and the related QA and QC test numbers
 - ▶ Example: IA01/QA01/QC01, IA02/QA03/QC14...
- ▶ For non-pay factor material, use the prefix “N”
 - ▶ Example: NQC01, NQC02...
- ▶ For correlation of the plant, use the prefix “COR”
 - ▶ Example: COR01, COR02...

Test Reports and Control Charts

- ▶ Training Manual (Section 5) has examples of DOT test forms
- ▶ Results must be furnished on DOT test forms
 - ▶ unless approved by the Engineer
 - ▶ Follow (**Gyratory**) numbering, reporting, and calculating procedures of the DOT
- ▶ Control Charts are to be maintained by the Contractor

Specifications

- ▶ Reclaimed Asphalt Pavement (RAP) (plan note %)
- ▶ Dust to Binder (uses effective asphalt content)
- ▶ Burner Fuel
 - ▶ up to Grade 6 allowed (used motor oil allowed), need cert with delivery
- ▶ Adding Lime
 - ▶ aggregate must have at least 1.0% moisture above SSD condition
 - ▶ enclosed twin-shaft pugmill must be used
- ▶ Bin splits adjusted only up to 5 percent
- ▶ Tolerances for Comparison between QC, QA and IA

Plant Site - Issues

- ▶ Stockpile contamination or segregation
- ▶ Bulkheads not used, material flowing into 2 bins
- ▶ Poor or unsafe aggregate sampling device
- ▶ Poor splitting procedures
- ▶ Not having proper scale and meter certs and checks
- ▶ Lime in air at plant site
- ▶ Burner fuel cert missing or incorrect material



Stockpile Contamination

A tall, white, cylindrical silo stands in the background, featuring a metal ladder on its side and a small structure at the top. In the foreground, several large, grey, conical concrete bins are arranged in a row, each supported by a metal frame. The bins are filled with a light-colored material, likely sand or gravel. The ground in front of the bins is a mix of dirt and gravel, with visible tire tracks. The sky is blue with scattered white clouds. A white text box is overlaid on the right side of the image.

No Bulkheads on Bins

QC Lab - Issues

- Incomplete records of equipment calibration
- No bulk specific gravity reheat test done
- Diaries not completed or lacking information and documentation
- Control charts not posted or updated in lab
- Back-up samples not labeled or kept for correct amount of time

QA Lab - Issues

- ▶ Not taking Verification (QA) samples
- ▶ Not conducting QA sample and splitting
- ▶ Bulk specific gravity reheat not done
- ▶ Moisture in mix test not completed
- ▶ Back-up samples not being retained
- ▶ Oil and lime cutoffs not witnessed

Recertification Exam

- ▶ The Exam is open book/notes
(Standard Specifications for Roads and Bridges - 2015,
QC/QA Asphalt Concrete Training Manual
and the Materials Manual)
- ▶ A score of 70% or better is required to
pass the exam.