Rocky Mountain Asphalt Education Center

Laboratory for the Certification of Asphalt Technicians (LabCAT)

Level B - Plant Materials Control

2024 Presentation Manual

In cooperation with the Colorado Asphalt Pavement Association, the Colorado Department of Transportation, and the Federal Highway Administration

STANDARD METHOD OF TEST FOR VERIFICATION OF EQUIPMENT USED TO TEST ASPHALT MATERIALS

CDOT CP 76 (CP -L 5101) LABORATORY EQUIPMENT

1

CP 76

This procedure covers the verification of equipment used to field test bituminous mixtures and provides documentation that the equipment verification has been done.

2

CP-L 5101
Verification of Laboratory Equipment Used to Test Bituminous Mixtures

- Superpave Gyratory
- Compression Machines
- Molds, Ram Heads, Base Plates, etc.
- Also covers gyratory maintenance
- Stabilometer, molds, followers, calibration cylinder
  - Both procedures contain schedules for maintenance, calibrations and verifications of equipment.

3

Questions???????????

4

STANDARD METHOD OF TEST FOR REDUCING FIELD SAMPLES OF ASPHALT MIXTURES TO TESTING SIZE

CDOT CP 55

1

SUMMARY

- Asphalt mixtures must be sampled in accordance with CP 41 (T-168).
- Samples must be split properly to obtain representative portions.
- This procedure is valid for asphalt mixtures having a nominal maximum particle size of 1.5 inch (37.5 mm) or less.

2

REPRESENTATIVE SAMPLES

To ensure representative samples:

- Employ techniques that are intended to minimize variations in measured characteristics between the test samples.
- Use proper equipment for the type of material to be reduced in size is important.
- Equipment must also be used properly to produce representative samples.
- Field sample shall be heated for minimum of I hour and not to exceed 4 hours at specified temperature prior to reducing to sample sizes.
- The 1 hour may include transport time, if in a container that retains heat.

3

MIXTURE PREPARATION

- **Heat to compaction temperature**
  - **Based on binder type & viscosity**

Table 1

SuperPave Binder grade	Lab Mixing Temperature	Lab Compaction Temperature
PG 58-28	310° F (154° C)	280° F (138° C)
PG 58-34	310° F (154° C)	280° F (138° C)
PG 64-22	325° F (163° C)	300° F (149° C)
PG 64-28*	325° F (163° C)	300° F (149° C)
PG 70-28	325 F (163 C)	300 F (149 C)
PG 76-28	325° F (163° C)	300° F (149° C)

Heat sample for a minimum of 1 hour, not exceeding 4 hours at the compaction temperature as specified in Table 1.

4

SPLITTING METHODS

- Method A-Selection by scoop
- Method B-Quartering
- Method C- Riffle type splitter
- Method D-Selection by cross section




5

PREPARATION FOR REDUCTION TO USE METHODS A, B, D

- Apparatus
  - Clean small flat square end scoop with sides.
  - Clean large flat bottomed mixing pan.


6

PREPARATION METHOD 1

- Place sample into large, flat bottomed pan without loss of material.
- Mix entire sample thoroughly 3 times.
- Flatten to uniform depth equal to or lower than the sides of the scoop.

7

PREPARATION METHOD 2

- Place the sample can into the mixing pan with the opening resting on the bottom of the pan (upside down).
- Elevate the can about 1 inch from the surface and move in a circular motion allowing the material to form a trail behind the can.
- Try to distribute the material in two or more layers.
- If visually segregated, mix the entire sample thoroughly and level as in Prep Method 1.

8

METHOD A-SELECTION BY SCOOP

- **Insert the scoop to full depth of the material.**
- **Lift scoop with minimal loss of material.**
- **Select a minimum of three increments.**
- **Small portions may be cut with a putty knife or similar tool for small quantity additions .**
- **Combine portions for test specimen of required mass.**
- **Save remaining portion until tests are completed.**

Shall not be used for combining & splitting large samples for testing between two or more labs.

9

METHOD B -QUARTERING

- Divide the sample into four equal quarters with scoop.
- Remove two diagonally opposite quarters.
- Re-mix the remaining two quarters.
- Repeat procedure until sample is the required mass for the test specimen, save remaining portion until tests are completed.

This method may be used for combining & splitting large samples for testing between two or more labs.

10

METHOD C- RIFFLE TYPE SPLITTER

- Splitters shall have a minimum of 8 chutes for coarse aggregates, 12 chutes for fine aggregates.
- The minimum width of the chutes shall be approximately 50 % larger than the *largest particles* in the sample.
- Place the sample in the mixing pan and mix thoroughly.
- Two procedures for depositing samples into splitter:
  - Flat scoop equal to width of riffles (feeder pan).
  - Extra splitter pans

  Shall <u>not</u> be used for combining & splitting large samples for testing between two or more labs.

11

RIFFLE SPLITTER BY SCOOP (FEEDER PAN)

- Remove material using the feeder pan.
- Pour half of the portion from one side.
- Reverse the ends of the feeder pan and pour the rest from the other side.
- Pour slowly to allow a free flowing condition.
- Continue until the entire sample has been introduced to the splitter.

12

RIFFLE SPLITTER BY SPARE PANS

- Place the sample into two spare pans placed side by side with scoop.
- Uniformly distribute the material from edge to edge.
- Pour ½ of the material into the splitter .
- Reverse the ends of the pan.
- Pour the remaining material into the splitter.

13

FEEDER PAN OR SPARE PANS METHOD

- Reintroduce the portion of the sample as many times as necessary to reduce the sample to the size specified.
- Use opposite pans for further reduction.
- Save the remaining material for additional tests.

14

METHOD D-CROSS SECTION

- Push a metal slat vertically through sample.
- Push a second slat through sample parallel to the first.
- Remove entire sample between the slats - take care to include all the fines on the tools.
- Obtain additional samples by pushing one of the slats vertically into the remaining material and repeating the process.

Shall not be used for combining & splitting large samples for testing between two or more labs.

15

QUARTERMASTER DEVICE

CP 55 states that this method may be used to split large samples for testing between two or more labs.

This Method shall not be used for further reduction in sample size.

17

QUARTERMASTER

18

QUARTERMASTER

- Used for combining & splitting large samples for testing between two or more labs
- Splitter is to be clean and heated to not exceed 110 C degrees by a non-contact temperature device.
- Pour samples into the hopper by using a continuous or segmented pour from multiple directions around the hopper
- Rotate the sample cans in a clockwise direction after each split
- Repeat until the specified sample size is achieved.

19

THE END

QUESTIONS?

20

Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens

CDOT CP 44

AASHTO T - 166

1

Purpose

- This procedure provides methods for determining bulk specific gravity to calculate the percent relative compaction of HMA and air void analysis.
- The Bulk Sp G is also used in determining the correlation factor for nuclear density gauges.

2

Method A Laboratory Compacted Diameter Specimens for 100mm and 150mm

3

Testing Apparatus Required

- Balance, with suspension apparatus.
- Wire of the smallest practical size at the penetration point of the water surface.
- Water bath with overflow outlet.
- Flannel or terry cloth towel

4

Specimen Preparation

- After removal from mold, allow specimen to cool to room temperature.
- Place cooled, dry specimen on scale and record dry mass.
- Immerse specimen in 77 +/- 1.8 F water bath for 4 +/- 1 minute.
- Record immersed weight.
- Remove specimen from water and quickly blot to SSD condition with a wet, freshly rung out terry or flannel cloth.
- Quickly place specimen on scale and record the SSD weight.

5

Bulk Specific Gravity Calculation

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

where:

A = mass (in grams) of dry sample in air
B = mass (in grams) of SSD sample, in air
C = mass (in grams) of sample in water

6

Percent Relative Compaction

Percent Relative Compaction =

$$\frac{\text{Bulk Specific Gravity}}{\text{Maximum Specific Gravity}} \times 100$$

7

Air Voids (Va) Calculation

Air Voids = 100 - % Relative Compaction

8

Convert Specific Gravity (Gs) to pounds per cubic ft (pcf)

- CDOT uses:
- Specific gravity x 62.4= Pcf
- Pcf/62.4 = Specific Gravity

9

Questions ??

10

Standard Method of Test for Determining the Asphalt Binder Content of Hot Mix Asphalt by the Ignition Method

CDOT CP L 5120

1

Summary of Test Method

- Per section 3.1, the binder in an APM sample is burned by ignition at a temperature high enough to ignite the asphalt binder fraction (due to the use of different models of ignition ovens, 8.2 of procedure is incorrect, it is not always 538˚C (1000˚F)

2

Summary of Test Method
(continued)

- Binder content is calculated by:
  - Dividing the mass loss of the specimen after ignition by the mass of the mixture before ignition.
  - The application of the correction factor, and the subtraction of the % of any moisture found.

3

Summary of Test Procedure

- This method determines the asphalt binder content by burning the binder off by ignition, the specimen gradation is then determined with the remaining aggregate residue.
- Not to be used for determining binder content of cores or otherwise obtained samples from existing bituminous pavements.

4

Overview

- Safety Issues
- Apparatus
- Sampling / Test Specimens
- Calibration
- Test Procedure
- RAP

5

Safety Issues

- Wear eye protection
- Wear long sleeves
- Wear clean, heat resistant gloves
- Location of furnace

6

Apparatus

- Forced air ignition furnace, that heats the sample by convection method or infrared heat source ignition method.
- Internal scale units will determine and indicate when the sample reaches a constant weight.
- There must be an internal balance thermally isolated from the furnace chamber that is readable to 0.1g.

7

Calibration

- Correction factors will be determined for the binder content and the aggregate loss.
- These factors will be determined for each mixture design and when mix ingredients change.
- This method may be affected by the type of aggregate in the mixture.
- A calibration factor must be performed prior to any acceptance testing.

8

Calibration Process

- The calibration process should be repeated each time there is a change in the mixture ingredients.
- Prepare three samples proportioned according to the JMF.
- Step One - Perform gradation analysis on an unburned "blank" specimen (no binder).

9

Calibration Process

- Step Two - Prepare two calibration samples at the design asphalt binder content.
- Burn the two samples as regular tests.
  - Note - after mixing if the specimens are allowed to cool, heat the material at binder compaction temperature for 30 minutes in a separate pan. Ignition oven baskets are not to be preheated before beginning this test.

10

Aggregate Calibration

- Perform a gradation analysis on the residual aggregate.
- If the potential of lime needs to be determined, introduce water over the residual aggregate and add 2-4 drops of phenolphthalein alcohol indicator. Let rest 10 seconds and look for the potential presence of lime.

11

Aggregate Calibration
(if degradation of aggregate occurred)

- Compare the gradations of the blank (unburned) specimen and the residual aggregate to evaluate the amount of aggregate breakdown.
- If it appears that degradation has occurred, by determining that the difference for any single sieve exceeds the allowable difference for that sieve as listed in Table 2, then proceed with the following procedure.

12

Aggregate Calibration

- If degradation is suspected-(Section 12 CP-L 5120)
  - Obtain a belt feed of the aggregate from the plant large enough for 4 specimens.
  - Determine the gradation of two blank specimens.
  - Mix 2 specimens at the design binder content, burn off the binder, perform gradation on residual aggregate.

13

Aggregate Calibration

- Compare the average gradation at each sieve size for the two sets of specimens.
- If the gradation for any single sieve exceeds the allowable difference for that sieve according to Table 2, then apply correction factors to all sieves in that range prior to any rounding or reporting.
  - Calculate to the nearest 0.1%, except for the #200, it shall be to the nearest 0.01%.
  - Report to nearest whole number, except for the #200 sieve, to the nearest 0.1%.

14

Aggregate Calibration

Table 2
Permitted Sieving Difference

- **Sizes larger than or equal to #8 ±5.0%**
- **Sizes larger than #200 and smaller than #8 ±3.0%**
- **Sizes #200 and smaller ± 0.5%**

15

Calibration Process To Determine the Binder Correction Factor

- **Determine the binder content for each sample by calculation.**
- **If the measured difference between the two burned samples is less than 0.15%, calculate the difference in binder content between the actual (optimum) and measured (mixed samples) binder contents for each sample.**
- **The calibration factor is the average of the differences between the actual and the measured asphalt contents for each sample.**

16

Binder Calibration Process

- If the measured difference between the two binder contents (burned samples) is greater than 0.15%:
  - Mix up an additional two samples and repeat the procedure.
  - Repeat procedure until the two results are within of each other 0.15%

17

Using the Ignition Oven w/ RAP

- The ignition oven can be used to determine the asphalt content of mixes containing RAP.
- Prior to performing the mix calibration, the percent binder (P_b) of the RAP must be determined by ignition with two RAP samples or the bitumen content from the mix design may be used.
- Chemical extractions for determining binder content on RAP are also used.

18

Using the Ignition Oven w/ RAP

- As with any materials, the sampling of RAP must be done carefully to result in samples that are representative of the larger mass of material.
- The gradation of the samples must be representative, gradation of specimen will affect the asphalt content results.

19

Calibration Process w/ RAP

- Weight of binder in RAP must be determined.
- As per 9.2.2 the weight of RAP required is determined.
- Then 9.2.3 has the formula for determining the weight of the binder in the RAP.
- The next step is to determine the weight of new binder to add, to result in the desired percent of binder for specimen. Found in 9.2.4.
- 9.3 covers mixing up samples using two or more RAP stockpiles.

20

Table 1: Size of Specimen

Nominal Maximum Aggregate Size(mm)	Sieve Size	Specimen Weight RANGE
4.75	#4	1200 - 1300
9.5	3/8″	1200 - 1300
12.5	½″	1800 - 1900
19.0	¾″	2200 - 2300
25.0	1 ″	3000 – 3100*
37.5	1.5 ″	4000 – 4100*

* Specimens shall be divided, each part tested, results averaged

21

Test Procedure

- All production samples must have a moisture correction determination.
- As per 8.1, specimen may also be dried to 0.00% moisture prior to placement in the furnace.
  - T110 or dry the HMA specimen to constant weight at 105 ± 5° C, [CP-43 at the specified binder compaction temperature for that mixture, as per Table 43-1 for a minimum of 3 hours]
- Preheat ignition oven per the manufacturer directions.

22

Test Specimens

- Weigh and record weight of sample baskets on external scale.
- Load test specimens into baskets 1 inch from sides.

23

Test Specimens

- Record total weight of basket and specimen.
- Determine and record the test sample weight.
- Enter the sample weight into the furnace computer.

24

Test Procedure

- Zero the internal scale.
- Open the chamber door and place the baskets into the furnace.

25

Test Procedure

- **Close chamber door and verify that the total weight (basket and material) equals the external recorded weight within ± 5 g.**
- **Differences greater than 5 g, or a failure of the scale to stabilize, indicates the baskets are contacting the furnace wall.**
- **Initiate the test by pressing the start button.**
- **This will lock the chamber door and start the combustion blower.**

26

- Allow the test to continue until the stable light and audible stable indicator indicate the test is complete (the change in weight is less than 0.01% for three consecutive minutes).
- Press the stop button to unlock the chamber door.

27

Test Procedure

- Open the chamber door.
- Remove the baskets from ignition oven.
- Allow specimen to cool for 40 +/- 5 minutes.
  - If the correction factor was not entered into the furnace, apply the correction factor before reporting the percent binder.

28

Test Procedure

- Weigh the basket assembly containing the residual aggregate on the external scale and record the weight.
- Calculate the uncorrected binder content.
- Correct the uncorrected binder content by applying the binder correction factor and subtracting any moisture found to be in the sample from the moisture determination procedure.

29

Calculations

$$P_{b(corr)} = P_{b(uncorr)} + C_F - P_w$$

Where:

$P_{b(corr)}$	=	Asphalt binder content of field produced specimens corrected for the aggregates and asphalt binder sources
$P_{b(uncorr)}$	=	Uncorrected asphalt binder, determined by the mass of the test specimen
C_F	=	Calibration factor, percent by weight of the HMA sample
P_w	=	Moisture content (percent water)

30

Precision

Allowable Standard Deviation

- **Single lab 0.20% RAP Mix**
- **Multi lab 0.40% RAP Mix**

31

Questions ?

32

Standard Method of Test for Theoretical Maximum Specific Gravity of Asphalt Paving Mixtures

CDOT CP 51

AASHTO T - 209

1

Purpose

- This method covers the determination of the maximum specific gravity of un-compacted asphalt paving mixtures.
- This method will assist with determining:
  - relative percent compaction
  - percent air voids

2

Apparatus Required

- Balance, with ample capacity and sensitivity.
- Heavy walled volumetric flask or other container.
- Flat, transparent cover plate.
- Fine wire mesh .
- Calibrated thermometer, ASTM 17˚C.
- Vacuum system, 3.7 ±0.3 kPa, (28 ± 2 mm Hg).
- Residual pressure manometer or pressure gauge.

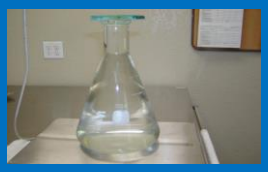
3

Procedure

- Flask calibration.
- Sample preparation.
- Test.
- Calculations.

4

Flask Calibration



- Perform once per month.
- Fill flask with water.
- Verify water temperature is 77 ± 1˚F (25.0 ± 0.5˚C).
- Overfill flask and level off with cover plate.
- Determine and record the mass of flask, water and cover plate.
- Identify and record the flasks and cover plate(s).
- Average of last three determinations and record.

5

Sample Preparation

- Samples shall be obtained according to (CP 41) T168.
- Samples shall be split according to (CP 55) T- 248.
- The sample size is based on the nominal maximum aggregate size of the mixture (Table 51-1).
- Two separately taken identical test specimens shall be obtained and not recombined.

6

TABLE 51-1: Required Sample Mass for Various Nominal Maximum Sizes of Aggregate

Nominal Maximum Size of Aggregate		Number and Minimum Mass of Specimens
Inches	MM	Specimens X grams
1.5	37.5	2 X 3000g
1	25.0	2 X 1500g
¾	19.0	2 X 1000g
½	12.5	2 X 750g
3/8	9.5	2 X 500g
No. 4	4.75	2 X 500g

7

Voids Analysis

- If laboratory or field produced specimens are to be compacted for voids analysis using CP-L 5115, the specimens used to determine the theoretical maximum specific gravity should be short-term aged using the same procedure as the specimens being compacted.
- Specimens maintained at a temperature above 200˚F (94˚C) for 1 hr or more do not require additional aging.

8

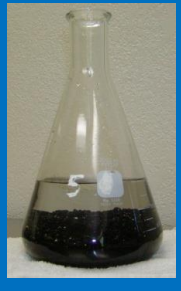
Sample Prep - Continued

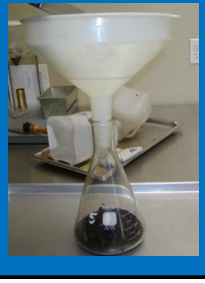
- Separate the fine particles of each sample so that they are no larger than ¼" inch.
- Take care not to fracture mineral particles.
- If mixture is not sufficiently soft to be separated, mixture may be warmed only until they can be so handled.
- Cool samples to room temperature

9

Test

- Tare flasks or record mass of each empty flask.
- Place samples into flasks.
- Record mass of each sample.
- Fill flask with water to a minimum of one inch above sample.





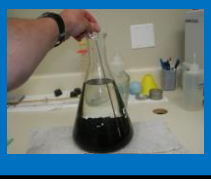
11

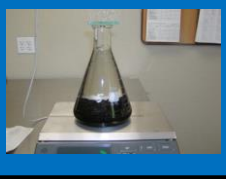
Test (continued)

- If the potential presence of lime in asphalt mixture needs to be determined, add 2-4 drops of phenolphthalein alcohol indicator
- Let rest 10 seconds, to show potential presence of lime
- Remove entrapped air under a partial vacuum of 28 ± 2 mm Hg for 15 ± 2 minutes.
- Agitate the samples and flasks at 2 minute intervals for 15 ± 5 s or continuously with mechanical device.

12

- Turn vacuum off, not faster than 8 kPa/sec (60 mm/s Hg).
- Fill flasks with water (@ 25.0 ± 0.5˚C).
- Stir sample with rod, if necessary.
- Finish filing flask with 77˚F water & slip lid onto flask.
- Place flask in 77 ± 1˚F (25.0 ± 0.5˚C) water bath.
- Bring the contents of the flasks to 25.0 ± 1.0˚C (77 ± 1˚F), rod sample to help eliminate air bubbles, remove any found under the lid and replace lid.
- Sample shall remain in 77 ± 1˚ water until water stabilizes at 77 ± 1˚F or for a minimum of 10 min , which ever is achieved first.
- Determine the mass of the flask, water, **sample** and lid for each sample within 2 min of removal from bath.



13

Test (continued)

- In lieu of a constant temperature bath as per section 6.5, determine the calibration masses at various test temperatures.
- Determine the final temperature of the samples.
- Make the appropriate density corrections.
- This process should be used with all suitable containers, not just the glass flasks.

14

Test (continued)

- If the aggregate is not completely coated:
  - CDOT- Follow Method A- Dry-Back – to be used if uncoated particles settle to the bottom of the flask. (They have absorbed water during the partial vacuuming process).

15

Calculations

Where: $Gmm = \frac{A}{A+D-E}$

A = mass of dry samples

E = mass of samples, water, flasks and cover plate(s)

D = calibration masses

The specific gravities must be within 0.011 of each other for a valid test.

16

Reporting Specific Gravity

- As per 10.1.1: The specific gravity of each specimen to the nearest 0.001
- The average specific gravity of two specimens to the nearest 0.001.

17

Questions?

18

STANDARD METHOD OF TEST FOR DETERMINING MOISTURE (WATER) OR VOLATILE DISTILLATES CONTENT OF ASPHALT PAVING MIXTURES

CP 43

1

SCOPE:

- THIS PROCEDURE COVERS TWO METHODS FOR THE QUANTITATIVE DETERMINATION OF MOISTURE IN ASPHALT PAVING MIXTURES.

2

METHOD A

- APPARATUS;
  - MICROWAVE OVEN - HAVING VARIABLE TIME AND POWER CONTROLS.
  - PYREX DISH (OR OTHER SUITABLE DISH) – CAPABLE OF HOLDING THE ENTIRE TEST SPECIMEN BEING TESTED.
  - BALANCE – HAVING SUFFICIENT CAPACITY AND SENSITIVITY TO 0.1G.

3

METHOD A – PROCEDURE FOR CALIBRATING THE MICROWAVE

- DETERMINE THE VARIABLE POWER SETTING:
  - SET THE VARIABLE POWER CONTROL TO APPROXIMATELY 50% POWER.
  - PLACE 550 ± 50 ML OF WATER OF TAP WATER IN A PYREX CONTAINER, RECORD THE TEMPERATURE OF THE WATER (T1).

4

METHOD A – PROCEDURE FOR CALIBRATING THE MICROWAVE (CONTINUED)

- SET THE MICROWAVE OVEN TIMER FOR FIVE MINUTES AND HEAT 550 ML OF WATER. RECORD THE TEMPERATURE (T2).
- THE DIFFERENCE BETWEEN THE TEMPERATURE T1 AND T2 SHOULD BE
  75° F ± 10° (42° C ± 6°).
- IF THE DIFFERENCE IS TOO LOW (OR HIGH) INCREASE (OR DECREASE) THE VARIABLE POWER SETTING AND REPEAT THE PROCESS.

5

METHOD A – MICROWAVE PROCEDURE

- PLACE A SPECIMEN IN A CLEAN, GLASS, DRY, TARRED CONTAINER AND OBTAIN THE SAMPLE MASS TO THE NEAREST 0.1G.
- THE SAMPLE WEIGHT SHOULD BE:
  - 550 ± 50 G FOR GRADING S AND SX MIXES
  - 2000 G FOR GRADING SG MIXES

6

METHOD A - PROCEDURE

- DRY THE SPECIMEN IN THE MICROWAVE OVEN USING THE VARIABLE POWER SETTING DETERMINED PREVIOUSLY.
- CONTINUE TO DRY THE TEST SPECIMEN UNTIL THE MASS OF THE SPECIMEN DOES NOT CHANGE AFTER FURTHER HEATING CYCLES FOR A 5 MINUTE PERIOD.
- CARE SHOULD BE TAKEN TO AVOID OVERHEATING THE SPECIMEN ~ AN INDICATION OF OVERHEATING IS BLUE SMOKE.

7

CALCULATIONS

- DETERMINE THE PERCENT MOISTURE TO THE NEAREST 0.01% AS FOLLOWS:

$$Percent\,Moisture = \frac{A - B}{A} X\ 100$$

$$Where\ A = Wet\ weight (mass)\ of\ test\ specimen$$

$$Where\ B = Dry\ weight (mass)\ of\ test\ specimen$$

8

METHOD B

- DRYING OVEN – THERMOSTATICALLY CONTROLLED FORCED DRAFT OVEN.
- SPECIMEN CONTAINER – CAPABLE OF HOLDING THE ENTIRE TEST SPECIMEN BEING TESTED.
  - BALANCE – HAVING SUFFICIENT CAPACITY AND SENSITIVITY TO 0.1G.
  - MISCELLANEOUS – KNIVES, SPATULAS, SCOOPS, TOOLS, ETC., AS REQUIRED IN APPLICABLE CP' S AND CP-L' S

9

METHOD B PROCEDURE (OVEN)

- PLACE THE SPECIMEN IN A CLEAN, DRY, TARRED CONTAINER AND WEIGH TO THE NEAREST 0.1G.
- THE SAMPLE WEIGHT SHOULD NOT BE LESS THAN:
  - 500 G FOR GRADING S AND SX MIXES
  - 2000 G FOR GRADING SG MIXES
- DRY THE SPECIMEN IN THE OVEN AT THE SPECIFIED BINDER COMPACTION TEMPERATURE FOR THAT MIXTURE (SEE TABLE 43-1), FOR A MINIMUM OF 3 HOURS.
  (TABLE 43 HAS BEEN UPDATED TO INCLUDE TEMPERATURES FOR PG 70-28)

10

METHOD B PROCEDURE (OVEN)

- REMOVE THE SPECIMEN AND IMMEDIATELY WEIGH TO THE NEAREST 0.1G.
- PLACE THE SPECIMEN BACK INTO THE OVEN TO CONTINUE DRYING, CHECKING THE MASS OF THE SPECIMEN EVERY ½ HOUR, ±5 MINUTES.
- THE SPECIMEN IS CONSIDERED DRY WHEN THE LOSS IN MASS IS LESS THAN OR EQUAL TO 0.1 GRAM.

11

CALCULATIONS

- DETERMINE THE PERCENT MOISTURE TO THE NEAREST 0.01% AS FOLLOWS:

$$Percent\,Moisture = \frac{A-B}{A}\,X\,100$$

$$Where\ A = Wet\ weight (mass)\ of\ test\ specimen$$

$$Where\ B = Dry\ weight (mass)\ of\ test\ specimen$$

12

QUESTIONS?

13

Standard Method of Test for Asphalt Binder Content of Asphalt Mixtures by the Nuclear Method

AASHTO T – 287

CDOT CP 85
Asphalt Cement Content of Asphalt Mixtures by the Nuclear Method

1

Purpose

- This method covers the determination of the asphalt cement (binder) mixture with a nuclear gauge.
- This method is a rapid determination of binder content (AC, binder).
- This procedure is sensitive to the type & gradation of aggregate, hydrated lime, percentage & source of binder.

2

Purpose

- Measures total hydrogen in sample, including any moisture in the form of water.
- Moisture correction must be performed (CP 43).
- When using RAP in mix design, the RAP used in the calibration samples must be uniform in gradation, asphalt content and asphalt type.

3

Required:

- Samples of binder and aggregate for the calibration process shall be sampled and prepared per procedure.
- Field samples of mix for binder content determination shall be obtained and reduced to test specimen size as per CP 55.
- Prior to gauge operation:
  - stationary location
  - away from water
  - away from other nuclear testing devices 33 feet (10 m)

4

Required Apparatus

- Content gauge.
- 3 or more metal sample pans #9 clean & undamaged condition.
- Metal plate or plywood (or wooden survey stake).
- Steel straightedge approx. 18 inches in length.
- Balance, 33 lb (15 kg), readable to 0.1 g.
- Large mixing bowl, misc. hand tools.
- Ovens.
- Microwave oven (CP - 43) for moisture determination.
- Thermometer from 50-500 °F (10 to 300 °C).

5

Procedure Steps

- Background Count
- Sample preparation
- Aggregate count
- Calibration
- Moisture content
- Test

6

Standardization (background)

- Top of gauge & surrounding area by 3 feet free of any hydrogenous type materials or personnel.
- Gauge empty and clean.
- Warm-up gauge a minimum of 20 minutes.
- Obtain background count for 16 minutes or a minimum 8 minutes.
- ± 1% from previous count.
- Statistical stability once per month.

7

Sample Preparation

- Obtain binder sample from job or supplier.
- Obtain aggregate samples from job or supplier.
- Obtain lime samples from job or supplier.
- Dry aggregates at 149 ± 8° C (300±15F) for a minimum of 3 hours or to constant weight.
- Heat binder to mixing temperature.
- Use job mix formula to blend aggregates in the correct proportion.

8

Dry Aggregate Count

- Fill pan half full.
- Drop 1 inch four times to compact.
- Fill pan above rim.
- Repeat dropping 1 inch four times.
- Level off with straight edge using a sawing motion strike it off so it is level with the rim of the pan.

9

Dry Aggregate Count
(continued)

- Record weight.
- Record temperature.
- Obtain and record count (16 minutes), repeat approximately once per week.
- Run to ensure that changes in the aggregate do not occur unnoticed.
- If a significant change is noted in this count ± 0.5 %, a new calibration should be run.

10

Mixing Samples

- Aggregates should be proportioned to the JMF.
- Correct amount of lime should also be mixed in with aggregates and sample hydrated before addition of binder.
- Mix samples with correct amount of properly graded binder.

11

Mixing Samples

- How much binder do you add?
  One formula is: Wb= (Ws x Pb)/(100-Pb)
- Where: Wb = Weight of binder, Ws = Weight of Stone, Pb = Percent of Binder.
- Assume 7000g of stone and 5% binder required.
  - Example: Wb= (7000X5.0)/(100-5.0)
    - Wb= 35000/95
      - Wb= 368.4g

12

Use of RAP

- If RAP is being used, the percent binder in the RAP must be known and the gradation of the RAP used must uniformly match the RAP gradation used in the mix design.

15

Calibration Curve Generation

- Mix a minimum of 3 calibration pans (commonly more): one @ optimum, one @ +1%, one @ -1% or range (commonly at 0.5% increments) expected on the project.

- Fill pan half full
- Level sample
- Fill pan above rim

16

Calibration Continued

- If this is the first pan, the weight that fills the pan well becomes the base weight for all the other calibration pans & test samples during production.
- The corners should be filled and normally the optimum pan should be the first pan made during calibration to establish the base weight.

17

Calibration Continued

- The sample should then be compacted at a temperature between 250° and 300° F. Obtain and record temperature of first sample to establish the calibration temperature.
- All samples during calibration should then be within ± 10° F of this temperature.

18

Calibration Continued

- Place sample in the gauge and obtain and record a 16 minute count.
- The result from the calibration pans should result in a correlation factor of 0.999 to 1.000 to be a valid calibration.
- If less than 0.999, new pans should be mixed and calibration run again.
- At conclusion, perform an additional background count. Variation greater than 1% from previous background count is unacceptable.
- Document all calibration information on CDOT form 599 or other approved form.

19

COLORADO DEPARTMENT OF TRANSPORTATION
NUCLEAR ASPHALT CONTENT CORRELATION

Aggregate source: Rocky Rocks	Date:	Correlation no.: 10
Asphalt: grade & source: PG 64-22 Koch	Grading: SX(75)	Supplier: Kiewit
Project No.: STA 054-21	Project code (SA#): 11925	Form 43 #: 25589
Background count: Start 1975 Finish 1976	Gauge No.: 13	Job mix formula % AC: 5.9

Dry Aggregate Information

A. Base weight: 7250 g — A' Base weight (mix): 7100 g

B. Gauge count on dry aggregate: 1950

Correlation

		Cor. Pan 1	Cor. Pan 2	Cor. Pan 3	Cor. Pan 4
C.	Weight of dry aggregate	8000 g	8000 g	8000 g	8000 g
D.	Percent asphalt required	4.90 %	5.9 %	6.9 %	7.9 %
E.	Weight of asphalt required ($\frac{C \times D}{100 - D}$)	412.2 g	501.6 g	592.9 g	684.2 g
F.	Desired weight of mix (C + E)	8412.2 g	8501.6 g	8592.9 g	8684.2 g
G.	Actual weight of aggregate and asphalt	8411.9 g	8501.3 g	8593.0 g	8684.7 g
H.	Actual weight of asphalt in mix (G - C)	412.2 g	501.6 g	592.9 g	684.2 g
I.	Actual % of asphalt in mix ($\frac{H}{G} \times 100$)	4.9 %	5.9 %	6.9 %	7.9 %
J.	Gauge count on mix sample	2927	3200	3488	3776
K.	Deviation	-.009	+.018	-.009	-.009

L. Correlation temperature: 280

M. Slope: 3.995 Intercept: -6.729 Correlation factor: .9993

Tested by:

Witnessed by:

Remarks:

Check pan by:

AC mixed at, %: 5.9

Gauge count: 3200

% AC by gauge: 5.91

CDOT Form #599 4/07

20

Test Procedure

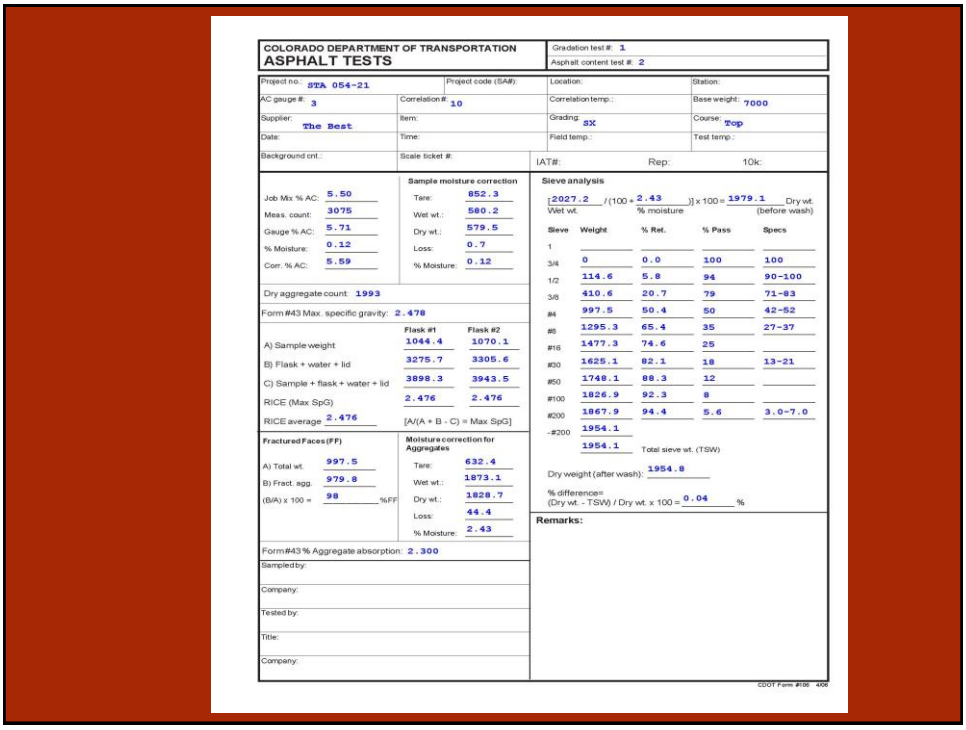
- Split out 2 samples, one for testing of %AC and one determining the %moisture from the field sample.
- Two methods can be used for determining the %moisture in CP 43: Method A Microwave or Method B Convection Oven.
- Fill pan half full.
- Level material in pan.
- Finish filling pan to base weight within 5 g.

21

Test Procedure (cont.)

- Check temperature prior to compaction (should be between 250° F and 300° F).
- Compact sample.
- Obtain 16 minute gauge count, record count & %Binder from gauge display.

22



COLORADO DEPARTMENT OF TRANSPORTATION
ASPHALT TESTS

Gradation test #: 1
Asphalt content test #: 2

Project no.: STA 054-21	Project code (SA#):	Location:	Station:
AC gauge #: 3	Correlation #: 10	Correlation temp.:	Base weight: 7000
Supplier: The Best	Item:	Grading: SX	Course: Top
Date:	Time:	Field temp.:	Test temp.:
Background cnt.:	Scale ticket #:	IAT#:	Rep: 10k:

Job Mix % AC:	5.50
Meas. count:	3075
Gauge % AC:	5.71
% Moisture:	0.12
Corr. % AC:	5.59

Sample moisture correction

Tare:	852.3
Wet wt.:	580.2
Dry wt.:	579.5
Loss:	0.7
% Moisture:	0.12

Dry aggregate count: 1993

Form #43 Max. specific gravity: 2.478

	Flask #1	Flask #2
A) Sample weight	1044.4	1070.1
B) Flask + water + lid	3275.7	3305.6
C) Sample + flask + water + lid	3898.3	3943.5
RICE (Max SpG)	2.476	2.476
RICE average: 2.476	[A/(A + B - C) = Max SpG]	

Fractured Faces (FF)

A) Total wt.	997.5
B) Fract. agg.	979.8
(B/A) x 100 =	98 %FF

Moisture correction for Aggregates

Tare:	632.4
Wet wt.:	1873.1
Dry wt.:	1828.7
Loss:	44.4
% Moisture:	2.43

Form #43 % Aggregate absorption: 2.300

Sampled by:
Company:
Tested by:
Title:
Company:

Sieve analysis

[2027.2 Wet wt. / (100 + 2.43 % moisture)] x 100 = 1979.1 Dry wt. (before wash)

Sieve	Weight	% Ret.	% Pass	Specs
1				
3/4	0	0.0	100	100
1/2	114.6	5.8	94	90-100
3/8	410.6	20.7	79	71-83
#4	997.5	50.4	50	42-52
#8	1295.3	65.4	35	27-37
#16	1477.3	74.6	25	
#30	1625.1	82.1	18	13-21
#50	1748.1	88.3	12	
#100	1826.9	92.3	8	
#200	1867.9	94.4	5.6	3.0-7.0
-#200	1954.1			
	1954.1	Total sieve wt. (TSW)		

Dry weight (after wash): 1954.8

% difference=
(Dry wt. - TSW) / Dry wt. x 100 = 0.04 %

Remarks:

CDOT Form #106 4/06

23

Test Procedure continued

- Correct the %Binder from gauge display by subtracting the % moisture (if it is determined that the sample contains moisture).

24

Take note there are two separate Base Weights!

- One for the Dry Aggreagate Count Process
- One for the actual Asphalt Mixture pans
- These are different processes

25

Questions?????

26

STANDARD METHOD OF TEST FOR REDUCING FIELD SAMPLES OF AGGREGATE TO TESTING SIZE

CDOT CP 32

1

PURPOSE OF SPLITTING

These methods provide for reducing large samples of aggregate to measure characteristics in a manner that the smaller test portion is most likely to be a representation of the larger sample, and thus of the total supply.

2

· **Aggregates must be sampled in accordance with**

· **Samples must be split properly to obtain representative test specimens.**

3

METHODS

- Method A - riffle type splitter
- Method B – quartering
- Method C –
  - Selection by scoop (CDOT)
  - Miniature stockpile method (AASHTO)

4

RIFFLE APPARATUS

- Riffle type splitter with variable size openings.
- Hopper to retain sample or flat scoop (feeder pan) equal in length to the overall assembly of chutes.
- Collection pans, minimum of two (2), equal in length to the overall assembly of chutes.
- Splitter brush to clean chutes of adhering fines.

5

QUARTERING APPARATUS

- 6 x 8’ quartering canvas or
- Clean, hard, level surface (AASHTO)
- Flat, square end shovel

6

SCOOP & MINIATURE STOCKPILE APPARATUS (FINE AGGREGATE ONLY)

- Large flat bottomed mixing pan (CDOT) or a clean, hard, level surface.
- Small, flat, square end scoop.

7

BY RIFFLE SPLITTER

- Riffle splitting is always preferable to hand quartering.
- Proper size openings required.
- Opening shall permit easy passage of the largest particles in the sample.
- For variable splitters the openings should be 1.5 times the size of the largest particles

8

METHOD A - RIFFLE SPLITTER

- An even number of equal width chutes, but not less than 8 for coarse, or 12 for fine aggregates
- The splitter shall be equipped with a hopper or straight-edged pan which has a width equal or slightly less the overall width of the assembly of chutes.
- Sample at SSD or drier.
- Two procedures to split sample:
  - Hopper
  - Scoop (feeder pan)

9

RIFFLE SPLITTER CONTROL FLOW HOPPER (CDOT)

- Sample poured into the closed hopper from the sample container.
- Use all material.
- Uniformly distribute from edge to edge.
- Open release handle and allow the sample to flow freely through the chutes.
- The first split that is then reintroduced to the splitter assists in mixing the sample.

10

Riffle Splitter Control Flow Hopper (CDOT)

- Then remove both pans from the splitter.
- Save material in one pan for other tests.
- Pour half of the remaining pan into the hopper.
- Reverse ends of pan.
- Pour the remaining sample into the hopper.

11

RIFFLE SPLITTER CONTROL FLOW HOPPER (CDOT)

- Uniformly distribute material in hopper.
- Open release handle and allow the sample to flow freely through the chutes.
- Use alternate pans for further reduction.
- Splitting is continued until the sample is reduced to the required specimen size.

12

RIFFLE SPLITTER WITHOUT CONTROL HOPPER (CDOT)

- Place entire sample in a large mixing pan and mix thoroughly.
- Scoop the material from the pan with the feeder pan.
- Uniformly distribute in feeder pan.
- First, slowly pour half the sample from one side.

14

RIFFLE SPLITTER WITHOUT CONTROL FLOW HOPPER (CDOT)

- Pour the other half from the other side.
- Continue until entire sample has been passed through the chutes.
- Use alternate pans for further reduction to desired specimen size.

15

METHOD B -QUARTERING

- Sample deposited on clean, hard, level surface or canvas (6’ X 8’ canvas).
- Mix material thoroughly by turning the entire sample over onto itself 3 times.

16

METHOD B -QUARTERING

- Material shoveled into cone.
- Cone flattened at apex into in circular layer.
- Diameter equals approx. 4-8 times the thickness.

17

METHOD B -QUARTERING

- Uniform thickness.
- Sample divided into two equal parts using a square shovel, pipe or stick under canvas if surface is uneven.

18

METHOD B -QUARTERING

- Procedure repeated at 90 degrees.
- Diagonal opposite quarters removed [include all fines].
- Remaining two quarters re-mixed.
- Procedure repeated until sample is reduced to required size.

19

METHOD C – MINIATURE STOCKPILE (CDOT SCOOP)

- Only for fine grained materials (minus 3/8 inches (9.5mm).
- Sample should be damp.
- Sample deposited into large pan and mixed 3 times.
- Form into conical pile. Flatten pile (as in quartering).
- Scoop to full depth of material.

20

METHOD C – MINIATURE STOCKPILE
(CDOT SCOOP)

- ▶Mix and sample to minimize the loss of particles.
- ▶Portions selected from five (three) locations.
- ▶Portions combined for required weight.

21

METHODS FOR REDUCING SAMPLES WHEN USING A MECHANICAL SPLITTER CONTAINING FREE MOISTURE

- Dry to at least SSD condition, using temps that do not exceed those specified for any tests.
- Then split to specified size.

OR

- Preliminary split with mechanical splitter having chute openings 1½" or more to reduce large sample to not less than 5000gr.
- Then dried as above and further reduced to desired size.

22

QUESTIONS ?

THANK YOU

23

Standard Method of Test for Materials Finer Than 0.075-mm (No. 200) Sieve in Mineral Aggregates by Washing and the Sieve Analysis of Fine and Coarse Aggregate.

–CDOT uses both:

CDOT CP 31

AASHTO T 11 / T 27

1

Summary

- The weight required (after drying) for this procedure, is based on the nominal maximum particle size.
- The -200 wash is performed to remove the finer material from the coarser particles for a more efficient result.
- The aggregate gradation is the distribution of particle sizes expressed as a percent of the total weight of the sample.
- The gradation is determined by passing the material through a series of sieves stacked with progressively smaller openings and weighing the material retained on each sieve

2

Apparatus Required

- Balance, with ample capacity and sensitivity (0.1 g)
- Sieves
  - For the -200 wash, a nest of two sieves, the lower a No. 200 and the upper with openings in the range of No. 8 and No. 16
  - For the Sieve Analysis, additional sieves, conforming to AASHTO M92 and ASTM E11

- Container, sufficient in size to contain the sample covered with water and to permit vigorous agitation without any loss of the sample or water
- Oven or hot plate.

3

Test Samples

- Aggregates must be sampled in accordance with CP 30.
- Aggregates must be mixed and reduced to test specimen size in accordance with CP 32

4

CP 31
Sieve Analysis & Materials Finer than the No, 200 by washing

- **AASHTO T 11 & T 27 (found in AASHTO portion of handout) shall be used to determine the sieve analysis of fine & coarse aggregates with the following exceptions:**
- **Table 31-1 still used for minimum sample mass.**
- **Moisture Correction process can still be used, according to following procedure.**

5

CP 31

- Split material into two approximately equal samples.
- Dry one sample to constant mass in oven at 230° F ± 9° oven or use a hotplate to determine % moisture.
- Determine dry weight of second sample:

  Wet weight/(100 + %moisture) X 100) = Corrected Dry Weight

6

Test Samples-Coarse Aggregate Table 31-1

Aggregate Nominal Maximum Size square openings,	Minimum Mass of Test Sample (AASHTO) (kg)	Minimum Mass of Test Sample Lb (kg)
3/8″	2	2.2 (1.0)
½″	4	3.3 (1.5)
¾″	11	4.4 (2.0)
1″	22	5.5 (2.5)
1.5″	33	11.0 (5.0)
2″	44	16.0 (7.5)

7

Procedure

- Dry the sample to constant mass @ 110 ± 5° C (230 ± 9° F) and determine the mass of the test sample.
- Use moisture correction method.

8

Procedure for the -200 wash

- Place the sample into container and cover with water.
- Add wetting agent if desired.
- Agitate the test sample with sufficient vigor to separate the particles finer than the No. 200 sieve and to bring the material into suspension.

9

Procedure, -200 wash (cont.)

- Immediately pour the wash water over the nested sieves avoiding the decantation of coarser particles of the sample.

10

Procedure, -200 wash (continued)

- The entire sample may be placed into the upper sieve and washed until the coarser fraction is clean, however all water must pass through the No. 200 sieve.
- Add a second charge of water (no wetting agent).
- Agitate and decant.
- Repeat this operation until the wash water is clear.

11

Procedure, -200 wash (continued)

- Return all material retained on the sieves to the container.
- Dry the washed aggregate to a constant mass at 230 ± 9°F (110 ± 5° C)
- Cool to room temperature, determine and record the dry mass of the material.

12

Before/After Sieve Weight Check

- Weigh & record weight of washed sample after drying prior to placing in the stack.
- Weigh & record weight of material from each sieve either individually or accumulatively.
- Final total weight should not differ by more than 0.3% of the original dry mass of the washed and dried sample.

$$\left(Difference \div OriginalDryMass\right) \times 100 =\leq 0.3\%$$

13

Sieving Procedure

- Separate the specimen over a series of suitable.
- Size sieves, including those required by the specifications, manually or mechanically.

- Do not overload sieves:
  - 12 inch = Approx. 500g
  - 8 inch = Approx. 200g

14

Sieving Adequacy

- Annual calibration of shaker.
- Test using different material types.
  - Hand shake each individual sieve for additional 1 minute.
  - Pan on bottom and lid on top.
  - Hold at slightly inclined angle and tap sharply with heel of hand.
  - 25 taps at each of 6 locations around the sieve = 150 taps.
  - Not more than 0.5% by weight of the total sample can pass.

Loss / original dry mass x 100= ≤ 0.5%

15

Procedure, Sieve (cont)

- Determine and record the mass of material retained on each sieve to 0.1g
  - individually
  - cumulatively

16

Procedure

- ▶Calculate the Moisture content

  M/C = (Wet – Dry)/Dry x 100

- ▶Calculate the original dry mass from the percent moisture when using moisture correction methods.

Wet Weight ÷ (100 + %M) X 100 = Corrected Dry Weight

- ▶Calculate percent retained to 0.1%

Sieve Weight ÷ Corrected Dry Weight X 100 = % Retained

- ▶Calculate the percent passing and report to nearest whole number except No. 200 to 0.1%

100 -% retained = % Passing

17

COLORADO DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS FOR AGGREGATES
NOT SPLIT ON THE No. 4 SIEVE

Project no.	Project code (SA#)
Proj. location	
Pit name	
Item	Class

Station			Test #		Station			Test #	
Specimen wt (dry) B 2383.7			Date		Specimen wt (dry) B 2383.7			Date	
Sieve	Weight	Percent retained	Percent passing	Specs	Sieve	Weight	Percent retained	Percent passing	Specs
1"	0.0		100		1"	0.0	0.0	100	
¾"	23.0	1.0	99		¾"	23.0	1.0	99	
⅜"	253.7	10.6	89		⅜"	230.7	10.6	89	
3/8"	452.1	19.0	81		3/8"	198.4	19.0	81	
#4	832.1	34.9	65		#4	380.0	34.9	65	
#8	1052.1	44.1	56		#8	220.0	44.1	56	
#16	1246.7	52.4	48		#16	196.6	52.4	48	
#30	1489.5	62.5	37		#30	241.0	62.5	37	
#50	1892.1	79.4	21		#50	402.6	79.4	21	
#100	2015.3	84.5	15		#100	123.2	84.5	15	
#200	2259.4	94.8	5.2		#200	244.1	94.8	5.2	
-#200	63.1				-#200	63.1			
TOTAL	2322.5		Within 0.3% of dry washed weight? Y or N		TOTAL	2322.5		Within 0.3% of washed dry weight? Y or N	
	Gradation Sample		Moisture Sample			Gradation Sample		Moisture Sample	
Pan ID					Pan ID				
Pan weight					Pan weight				
Wet weight + Pan					Wet weight + Pan				
Wet weight	A		550.2		Wet weight	A		550.2	
Dry weight + Pan					Dry weight + Pan				
Dry weight	B		525.1		Dry weight	B		525.1	
Dry wash weight / H2O Loss			25.1		Dry wash weight / H2O Loss			25.1	
2323.1 / % H2O			4.8		2323.1 / % H2O			4.8	
Wet weight ÷ (100 + % H2O) x 100 = Dry weight					Wet weight ÷ (100 + % H2O) x 100 = Dry weight				
A 2500.5 ÷ (100 + 4.8) x 100 = B 2383.7					A 2500.5 ÷ (100 + 4.8) x 100 = B 2383.7				

Cumulative Weights

Individual Weights

18

Questions?

19