Rocky Mountain Asphalt Education Center

Rocky Mountain Asphalt Education Center

Welcome to the LABORATORY for the CERTIFICATION of ASPHALT TECHNICIANS (LabCAT) 2026

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Rocky Mountain Asphalt Education Center

Asphalt Technicians Certification Program

Levels **A**, **B**, **C** and **C** Minus Design

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Introductions

- ❑CAPA/RMAEC Staff
- ❑LabCAT Board of Directors
- ❑LabCAT Technical Committee

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Colorado Asphalt Pavement Association (CAPA)
Rocky Mountain Asphalt Education Center (RMAEC)

Tom Peterson, CAPA,	**Executive Director**
Tom Clayton, SET	**CAPA/RMAEC, Director of Training & Member Services**
Vacant 5/2025	**CAPA, Director of Engineering**
Diane Hammond	**RMAEC, Training Coordinator**
Greg Potts	**RMAEC, Instructor**

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LabCAT Board of Directors

Ken Coulson	**Coulson Excavating**
Ed Wells	**Connell Resources**
Craig Wieden	**CDOT Staff Materials**
Jody Pieper	**RME - CDOT R-2**
Brian Dobling	**Colorado Division Office-FHWA**
Craig Vaughn	**CMT Technical Services**
Tim Webb	**RME CDOT R-5**
Justin Cupich	**Kumar and Associates**
Tom Peterson	**CAPA**

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LabCAT Technical Committee

Vincent Battista	**CDOT, Asphalt Pavement Services Manager**
Patrick Kowing	**FHWA – Central Federal Lands Division**
Johnny Lam	**CDOT, Asphalt Pavement Program**
Greg Potts	**RMAEC, Instructor**
Ethan Wiechert	**Earth Engineering**
Tom Clayton	**RMAEC, (Co-Chair)**
Tammy Buck	**HDR**
Eric Biggers	**Martin Marietta**
David Fife	**United Companies, a CRH Company**
David Chelgren	**Martin Marietta**
Mike Gallegos	**CDOT, R-1 Lab Manager**
Lisa Wisner	**CDOT, R-5 Materials**
Jeff Cuypers	**Brannan Sand and Gravel**
Dylan Hullinger	**Balanced Engineering**

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Asphalt Technician Certification Program

- Certification A – Laydown
- Certification B - Plant Materials Control
- Certification C – Volumetrics, Gyratory, Stability & Lottmans
- Certification C Minus Design – Volumetrics and Gyratory Compaction
- Certification E - Aggregates
- Certification I – Asphalt Inspector

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Certification Schedule - Tuesday

8:00 am

Certification Level A

QC/QA	**Owners, Contractors, Consultants**
Random Sampling Plans	**CP 75**
Sampling Aggregate	**CP 30**
Sampling Asphalt Mix	**CP 41,**
Bulk SP G for Roadway Cores	**CP 44, Method B**
In-Place Density by Nuclear Method	**CP 81**
Compaction Test Section	**CP 82, Field Cores**

Certification: Electronic exam on Level A Procedures - 60 minutes

Following the electronic exam, laboratory proficiency testing will occur.

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Certification Schedule - Wednesday

8:00 am

Certification Level B

Verification of Lab Equipment	CP 76, CP-L 5101
Splitting Asphalt Mixture	CP 55
Determination of Moisture in HMA	CP 43
Bulk SpG for Lab Compacted Specimens	CP 44 Method A
Maximum Specific Gravity (RICE)	CP 51
Asphalt Content by Ignition Method	CP-L 5120
Asphalt Content by Nuclear Gauge	CP 85
Splitting Aggregate	CP 32
-200 Wash & Sieve Analysis	CP 31, AASHTO T11/T27

Certification: Electronic exam on Level B Procedures - 90 minutes

Following the electronic exam, laboratory proficiency testing will occur.

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Certification Schedule - Thursday

8:00 am

Certification Level C

Mix Volumetric Properties + VMA	CP 48
Superpave Gyratory Compactor	CP-L 5115
Hveem Stability	CP-L 5106
Resistance to Moisture Induced Damage (Lottman)	CP-L 5109

**Certification for "C minus design" will not cover CP-L 5106 or 5109*

Certification: Electronic exam on Level C Procedures - 60 minutes

Following the electronic exam, laboratory proficiency testing will occur.

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Safety in the RMAEC Lab

Materials & Equipment

- Nuclear Gauges (Source removed)
- Heated Mixture samples (Level C only)
- Forced Draft Ovens (Level C only)
- Compression Testing Machine (Level C only)
- Gyratory Compactors (Level C only)

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Other Information

- ❑Coffee, drinks, and snacks – as you walk in
- ❑Lunch - provided
- ❑Breaks - as needed
- ❑Restrooms - main building hallway on the left

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Handouts Provided

- ❑**LabCAT Presentation Manual** (slide presentations – this book)
- ❑**Evaluations** (first page in the presentation manual). *Please complete the critique form and return it prior to leaving our facility*
- ❑**Procedure Manuals** (CP/CP-L/AASTHO/ASTM) These are to be referenced during your electronic exam and will be available to reference while waiting to demonstrate laboratory proficiencies. These MUST BE RETURNED at the end of each day
- ❑**QR Code** (for your electronic exam each day)
- ❑**Test and Laboratory Proficiency Tracker**

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LabCAT Program Policies

Electronic Exam

- ❑Electronic exams are closed book. No personal notes are allowed during testing. Electronic exams are timed
- ❑An over all score of **80% or higher is required to pass** the exam portion of certification. Tests are scored electronically
- ❑A second electronic exam will be available following in the event the first exam result is less than the percentage required to pass
- ❑The option to review the failed questions, is also available before starting the second exam
- ❑Participant will be required to retest the entire exam and pass with an 80% or higher score

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LabCAT Program Policies

Laboratory Proficiencies

- ❑Laboratory proficiencies are graded **Pass / Fail**.
- ❑Laboratory procedure proficiency testing is closed book. Technicians will be required to independently demonstrate proficiency in each laboratory procedure required per certification level.
- ❑If the technician does not pass the first attempt (**Trial 1**) a second attempt (**Trial 2**) is allowed.

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Failure/Re-test Policy

Re-Test Fees are $150.00

No Refund or consideration will be given to a Technician who begins a session and chooses not to complete the session on the scheduled day. A Technician who chooses to leave a session will be considered as failing and will need to retest as described in the *"**Retest Policy**"*.

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Proctors

Where do our proctors come from?

- ❑ CDOT
- ❑ Local + Federal Agencies
- ❑ Contractors
- ❑ Consultants

How do I become a proctor?

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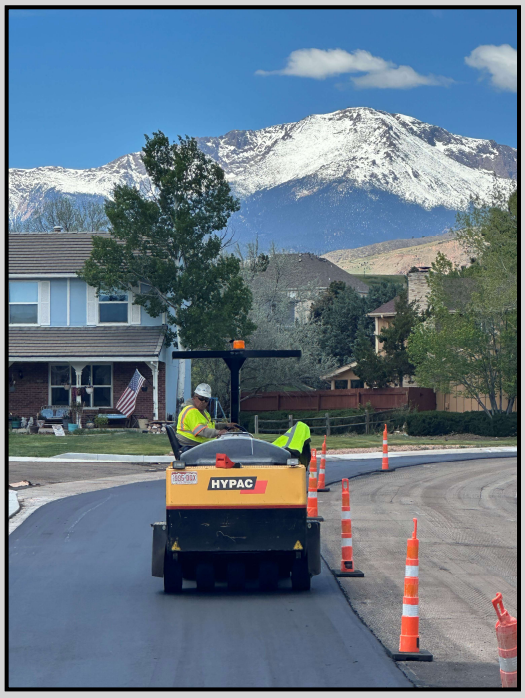
Let's Roll!

QUESTIONS?



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QUALITY CONTROL QUALITY ASSURANCE

- **Quality Control** – "Process Control" testing done by or for the producer/contractor
- **Quality Assurance** – "Acceptance" testing done on behalf of the owner – often by hired consultants
- **Check Testing** – A process to demonstrate a level of precision between two or more laboratories, providing shared confidence for all parties involved
- **Independent Assurance** – Intermittent testing by the owner (CDOT) to verify precision and provide an "audit" level of assurance on the project

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THE CONTRACTOR'S PC PROGRAM

- The contractor is required to perform quality control testing on the materials they produce and install
- The "Process Control" program is outlined in CP-12A of the CDOT Field Materials Manual
- This Standard describes the best practice to be used when developing appropriate worksheets and forms in a Process Control (PC) notebook
  - Project information (dates, times, locations)
  - Personnel involved, sampling methods used
  - Sample quantities, test specimen sizes
  - Test result reporting criteria
  - Interpretation of test results

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THE CDOT OWNERS "OA" PROGRAM

The "Acceptance" program is outlined in 106.05 of the CDOT Standard Specifications for Road and Bridge Construction manual – it provides guidance for:

- ❑ Frequency guide schedule
- ❑ Sampling locations
- ❑ Project verification sampling and testing
- ❑ Independent Assurance Testing
- ❑ Project materials certification
- ❑ Retention of sampling and testing records

Table 106-1
SCHEDULE FOR MINIMUM
SAMPLING AND TESTING FOR HMA

Element	Process Control	Acceptance*, #	Check (CTP)
Asphalt Content	1/500 tons	1/1000 tons	1/10,000 tons
Gradation	1/Day	1/2000 tons	1/20,000 tons
Theoretical Maximum Specific Gravity	1/1000 tons, minimum 1/Day	1/1000 tons, minimum 1/Day	1/10,000 tons
In-place Density	1/500 tons	1/500 tons	1/5000 tons
Joint Density	1 core/2500 linear feet of joint	1 core/5000 linear feet of joint	1 core/50,000 linear feet of joint
Aggregate Percent Moisture ^	1/2000 tons, minimum 1/Day	1/2000 tons	Not applicable
Percent Lime ^,+	1/Day	Not applicable	Not applicable

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THE CHECK TESTING PROGRM

The purpose of check testing is to compare the testing equipment and personnel that will be used according to the contract. With the successful completion of check testing within acceptable limits, both the Engineer and the Contractor should have confidence in the test results.

The subject test is performed on at least **five split samples**. In the case of in place density of HMA pavements, seven test locations are used. Calculate the absolute values of the differences between test results on each sample.

2025 CDOT FMM 10-01-2024 CP 13

TABLE 13-1
Acceptable Limits of Two Laboratory Test Precision

Element (Procedure)	Column 1 σ (Base Data, two operators, split sample)	Column 2 δ (Maximum Difference, split sample)	Column 3 δ (Acceptable Check Test Limit)
Asphalt Content [Nuclear Method] (CP 85)	0.25%	0.69%	0.31%
Asphalt Content [Ignition Method] (CP-L 5120)	0.25%	0.69%	0.31%
HMA #4 Sieve (CP 31)	2.04%	5.65%	2.53%
HMA #8 Sieve (CP 31)	1.92%	5.32%	2.38%
HMA #200 Sieve (CP 31)	0.56%	1.55%	0.69%
HMA Voids in the Mineral Aggregate (CP 48)	0.40%	1.11%	0.50%
HMA Air Voids (CP-L 5115)	0.37%	1.03%	0.46%
HMA Hveem Stability (CP-L 5106)	3.9	10.8	4.8
HMA Maximum Specific Gravity (CP 51)	.009	.025	.011
In-Place Density HMA (CP 44) (CP 81)	0.70% 0.72%	1.94% 2.00%	0.87% 0.89%
Longitudinal Joint Density (CP 44)	1.29 %	3.58%	1.60%
Compressive Strength PCCP (ASTM C 39)	192 psi (1324 KPa)	532 psi (3670 KPa)	238 psi (1641 KPa)
Sand Equivalent (CP 37)	3 points	8 points	4 points
Flexural Strength PCCP (AASHTO T 97)	44 psi (303 KPa)	122 psi (840 KPa)	55 psi (376 KPa)
In-Place Density Soils (CP 80)	0.34 pcf (5450 g/m³)	0.94 pcf (15197 g/ g/m³)	0.42 pcf (6756 g/m³)
In-Place Soil Moisture (CP 80)	0.45 pcf (7210 g/m³)	1.25 pcf (19985 g/m³)	0.56 pcf (8938 g/m³)

IMPORTANT

Contractors who do not participate in the check testing program cannot dispute acceptance test results!

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WHY ARE YOUR TEST RESULTS SO IMPORTANT?

- The sampling, splitting and overall handling techniques affect test results.
- Test results must be accurate when input into the CDOT acceptance programs for proper **incentive or disincentive** to be applied.
- Test results must be accurate to determine the quality of pavement, which affects both the short term and long term, performance of the roadway.
- Reputations can be greatly impacted – positively and negatively.

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THE MOVING QUALITY LEVEL

- Three reference conditions can exist determined by the Moving Quality Level (MQL).
- The MQL will be calculated per the procedure in CP 71 for Determining Quality Level (QL).
- The MQL will be calculated using only acceptance tests.

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THE MOVING QUALITY LEVEL

Item 403S Cost/ton: $35.00

% Max Density

Upper Test Limit: 96.0 V Factor: 1.10
Lower Test Limit: 92.0 W Factor: 0.40

Test No.	Date	Quant Repr.	Total Quant.	Density	MQL
1	06/11/00	500	500	94.20	
2	06/12/00	500	1000	92.40	
3	06/12/00	500	1500	93.60	100
4	06/12/00	500	2000	93.30	100
5	06/13/00	500	2500	94.20	100
6	06/13/00	500	3000	92.90	100
7	06/14/00	500	3500	94.20	100
8	06/14/00	500	4000	93.90	100
9	06/15/00	500	4500	93.90	100
10	06/15/00	500	5000	93.90	100
11	06/18/00	500	5500	94.40	100
12	06/18/00	500	6000	94.30	100
13	06/19/00	500	6500	93.90	100
14	06/19/00	500	7000	94.30	100
15	06/20/00	500	7500	94.70	100
16	06/20/00	500	8000	92.70	100
17	06/20/00	500	8500	93.60	100
18	06/21/00	500	9000	92.70	100
19	06/21/00	500	9500	94.10	100
20	06/22/00	500	10000	94.20	100
21	07/06/00	500	10500	93.20	100
22	07/06/00	500	11000	94.50	100
23	07/10/00	500	11500	93.60	100
24	07/10/00	500	12000	92.70	100
25	07/10/00	500	12500	93.70	100
26	07/10/00	500	13000	93.00	100
27	07/11/00	500	13500	93.40	100
28	07/11/00	500	14000	94.80	100
29	07/12/00	500	14500	94.50	100
30	07/12/00	500	15000	95.00	100
31	07/12/00	500	15500	92.20	99
32	07/13/00	500	16000	93.00	96
33	07/13/00	500	16500	90.60	70

Consistently passing does not guarantee a high MQL.

The results themselves need to be consistent to each other.

Passing, but inconsistent results (within the specification limit) can generate a poor MQL.

% Max Density Process Summary

Process 1 Tests 1-33 Quantity 16500 tons PF= 1.05201 I/DP=$12,014.13
Mean: 93.624 Std.Dev: 0.905 QL = 96.341

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THE MOVING QUALITY LEVEL

Item 403S Cost/ton: $35.00

% Max Density

Upper Test Limit: 96.0 V Factor: 1.10
Lower Test Limit: 92.0 W Factor: 0.40

Test No.	Date	Quant Repr.	Total Quant.	Density	MQL
1	06/11/00	500	500	94.20	
2	06/12/00	500	1000	92.40	
3	06/12/00	500	1500	93.60	100
4	06/12/00	500	2000	93.30	100
5	06/13/00	500	2500	94.20	100
6	06/13/00	500	3000	92.90	100
7	06/14/00	500	3500	94.20	100
8	06/14/00	500	4000	93.90	100
9	06/15/00	500	4500	93.90	100
10	06/15/00	500	5000	93.90	100
11	06/18/00	500	5500	94.40	100
12	06/18/00	500	6000	94.30	100
13	06/19/00	500	6500	93.90	100
14	06/19/00	500	7000	94.30	100
15	06/20/00	500	7500	94.70	100
16	06/20/00	500	8000	92.70	100
17	06/20/00	500	8500	93.60	100
18	06/21/00	500	9000	92.70	100
19	06/21/00	500	9500	94.10	100
20	06/22/00	500	10000	94.20	100
21	07/06/00	500	10500	93.20	100
22	07/06/00	500	11000	94.50	100
23	07/10/00	500	11500	93.60	100
24	07/10/00	500	12000	92.70	100
25	07/10/00	500	12500	93.70	100
26	07/10/00	500	13000	93.00	100
27	07/11/00	500	13500	93.40	100
28	07/11/00	500	14000	94.80	100
29	07/12/00	500	14500	91.90	92
30	07/12/00	500	15000	91.80	77
31	07/12/00	500	15500	92.00	71
32	07/13/00	500	16000	91.90	63

Multiple failures will trigger condition red

% Max Density Process Summary

Process 1 Tests 1-32 Quantity 16000 tons PF= 1.04963 I/DP=$11,117.83
Mean: 93.497 Std.Dev: 0.869 QL = 95.919

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WHAT YOU DO IMPACTS THE PROJECT AT THE HIGHEST LEVEL

A

QUESTIONS?

9

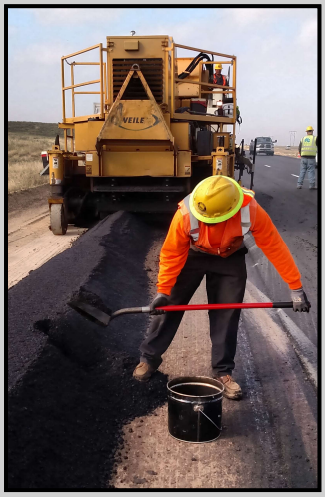
Stratified Random Sampling of Materials

CDOT CP 75

1

Stratified Random Sampling of Materials

- Sampling is one of the most critical steps in materials testing
- It is the nature of random sampling that some samples will represent below average or above average material



2

Stratified Random Sampling of Materials

CDOT specifications call for using the

Stratified Random Sampling Process

- This ensures that any portion of the material on a project has an equal chance of being selected
- Bias *can be* introduced when judgment is used

3

Stratified Random Sampling of Materials

- If not chosen randomly, the tests may not reflect the true characteristics of the material being evaluated.
- Stratified random sampling requires that one random sample is selected from each **sub lot**.
- Ensures that samples are selected uniformly throughout the entire production process.

4

Random Number Schedule

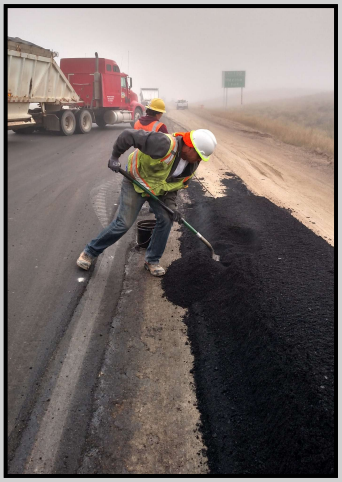
- It is the responsibility of the tester to ensure that the minimum sampling frequency is met.
- The random number schedule should be predetermined and not shared with the supplier or contractor before sample is taken.
- CP 75 contains complete instructions on accessing and using the programs for this process.

VOIDS 03 **ASPHALT 03**

5

Random Number Schedule

- Sampling should take place as close as possible to the values represented on the sampling schedule
- Major deviations from the sampling schedules should be noted in detail



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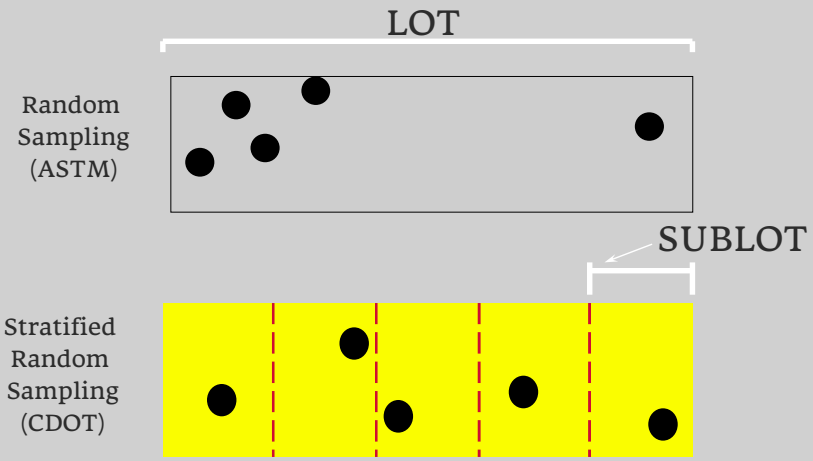
Lots and Sublots



Stratified Random Sampling methods will be used on ALL CDOT Projects

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QUESTIONS?

8

Standard Method for Sampling of Aggregates

CDOT CP 30

1

Sampling

These methods apply to the sampling of aggregates used in acceptance and quality control from various sampling locations as designated for construction materials including aggregate base course and aggregates for asphalt mixtures.

2

Key Points

- ❑Sampling is equally as important as the testing of the aggregate materials
- ❑Samples must be taken properly to represent the true characteristics of the materials
- ❑Segregated materials are not to be sampled
- ❑Samples must be selected from all the material being produced via CP 75 (Stratified Random Sampling)

3

Sampling Responsibilities

- ❑The **CONTRACTOR** performs the actual sampling of the materials
- ❑The OWNER'S AGENT (CDOT, Consultants) witnesses the sampling, and takes possession of a split sample

4

Sampling Locations

- ❑Stockpiles – With & Without Power Equipment
- ❑Flowing Aggregate Stream
- ❑Stopped Conveyor Belt
- ❑Processed Windrows
- ❑Roadway – Bases & Subbases
- ❑Cover Coat Material Spreader

5

Stockpiles

- ❑Stockpile sampling is the most common method of sampling aggregate materials prior to being delivered to the project
- ❑Sampling should only be done by or under the direction of experienced personnel
- ❑Power equipment should be used if stockpiles are to be sampled – sampling by hand would be the last resort

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Stockpiles

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Power Equipment

- ❑Remove segregated material from the stockpile sides
- ❑Expose a representative face
- ❑Channel the face from bottom to top

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Power Equipment

- Combine and mix the material to form a separate small pile

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Power Equipment

- Flatten the pile to a depth not thicker than approximately 1ft
- Sample from at least three (3) locations from the “sample pad”
- Combine all portions to meet or exceed Table 30-1

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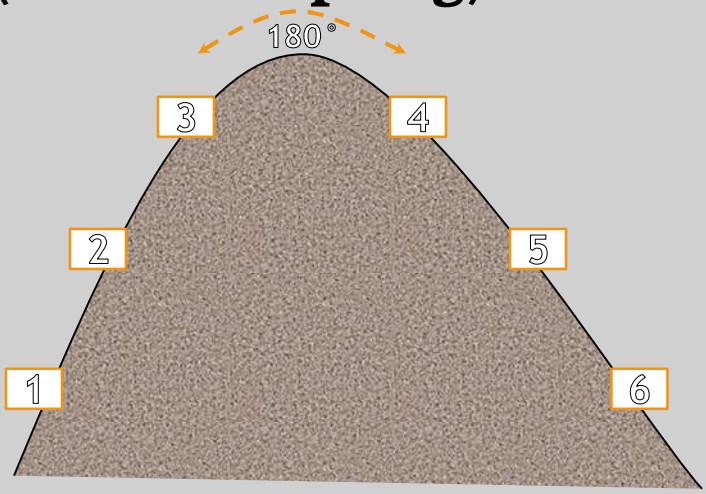
A

Stockpiles (Hand Sampling)

- Obtain portions of the sample from the top third, mid-point and bottom third of the stockpile
- Take two sets of three samples 180° apart



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Stockpiles (Hand Sampling)

- Insert the shelf upslope of the sampling point
- Remove the top six (6) inches outer layer of material
- Use a flat square end shovel, sample full depth
- Combine all portions to meet or exceed Table 30-1

REMINDER – *sampling with power equipment is preferable, this method is only a back up plan*

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A

Stockpiles (Hand Sampling)

Insert the shelf upslope of the sampling point

Remove the top six (6) inches outer layer of material

Use a flat square end shovel, sample full depth

13

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A

Stockpiles – Fine Aggregate (- 3/ 8 in.) using a sampling tube

- Sampling tube approximately **1.25 in. minimum diameter by 6 ft. long** inserted horizontally at a minimum of **5 (five) locations** to form the sample

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Flowing Aggregate Stream (Belt Discharge with Hand Tools)

- ❑ If safe and practical to stand within 2' of belt discharge
- ❑ Obtain one or more equal increments
- ❑ Several quick passes from entire cross section of flow
- ❑ Container shall be at least 12" diameter with sufficient capacity to hold entire sample
- ❑ Combine to form field sample that meets or exceeds the minimum recommended in Table 30-1

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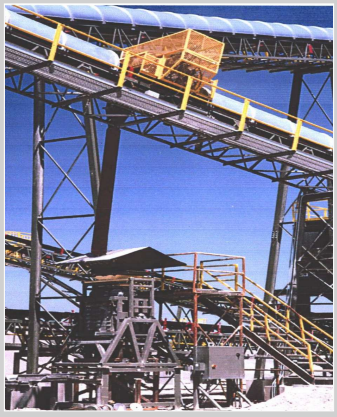
Flowing Aggregate Stream (Automatic Belt Sampler)

- ❑ Must cut the full charge of the belt without any loss of any portion
- ❑ Take one or more increments that when combined meets or exceeds the minimum sample size in Table 30-1



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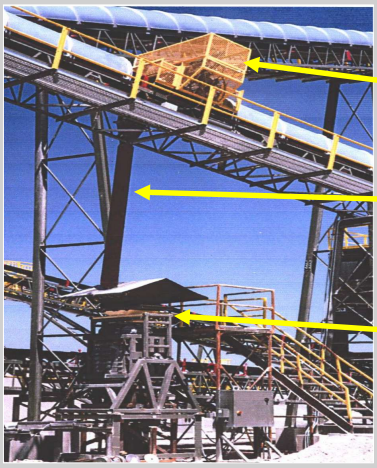
A

Flowing Aggregate Stream (Automatic Belt Sampler)



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Flowing Aggregate Stream (With Power Equipment)

- ❑Loader bucket positioned under belt discharge and filled
- ❑Combine and mix to form a separate small pile
- ❑Flatten the pile not thicker than approx. 1 ft

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Flowing Aggregate Stream (With Power Equipment)

- ❑Sample from at least 3 locations through full depth of the "sample pad" created using a flat, square end shovel.
- ❑Combine all portions to meet or exceed Table 30-1

Whenever power equipment is used, the "sample pad" method should always follow.

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A

Stopped Conveyor Belt

- ❑Stop the conveyor belt
- ❑Insert two templates <u>contoured to fit the belt</u>
- ❑Obtain at <u>least 1 (one) increment</u> (CP 30) that meets or exceeds the value in Table 30-1

Unlikely sampling method – the conveyor belts are rarely stopped

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A

Stopped Conveyor Belt

- ❑Distance between templates to yield an increment of the required weight
- ❑Remove all material between the templates
- ❑Use a brush and dustpan to remove all of the fine aggregate
- ❑Combine all portions

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A

Processed Windrows

A “windrow” is essentially a long stockpile – left either by belly dump semi’s or from motor graders working the material onsite.

22

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A

Processed Windrows

- ❑Use a flat, square end shovel, take care to not lose particles off the shovel
- ❑Remove material from one side toward the center to the full depth until a representative face is exposed
- ❑Channel the exposed face from bottom to top
- ❑Sample from at least three equally spaced locations on the exposed face
- ❑Combine all portions to form sample that meets or exceeds Table 30-1

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A

Roadway

A template may be used but is not required

- ❑Sample from random locations
- ❑Avoid segregated areas
- ❑Minimum of 3 approximately equal increments
- ❑Use flat square end shovel
- ❑Combine all portions to meet or exceed Table 30-1

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Roadway

- Remove material full depth of lift, combine the increments

- Take care to exclude any underlying material

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Cover Coat Material Spreader (Chip Seal Application)

- Last possible location prior to placement on the pavement
- Spreader must be stopped
- Samples will be taken from minimum of 3 individual gates as it is falling from the spreader
- Combine all incriments to meet or exceed Table 30-1

**With the engineer's approval, material may be sampled from the stopped conveyor belt on the transfer device, or from the stockpile*

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Nominal Maximum Particle Size

Nominal Maximum Particle Size is…

"One sieve size larger than the first sieve that retains more than 10% of the aggregate sample"

(*For SHRP/Superpave – as defined in the Appendix of the CDOT FMM – Item 403*)

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Nominal Maximum Particle Size

Sieve Size mm (in.)	Aggregate % Passing		
	A	B	C
19 (3/4)	100	100	100
12 (1/2)	88	*93*	*90*
9.5 (3/8)	78	88	79

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Nominal Maximum Particle Size

- Minimum sample sizes/weights are based off of **Nominal Maximum Particle Size**
- Table 30-1 near the end of CP-30 provides values for aggregate sizes between #8 and 3.50”

29

Nominal Maximum Particle Size

- Minimum sample sizes/weights are based off of **Nominal Maximum Particle Size**
- Table 30-1 near the end of CP-30 provides values for aggregate sizes between #8 and 3.50”

TABLE 30-1: Size of Field Samples

Nominal Maximum Aggregate Size of Aggregates[A]	Minimum Weight of Field Sample lbs.
Fine Aggregate	
No. 8	10
No. 4	10
Coarse Aggregate	
3/8 in.	15
1/2 in.	20
¾ in	25
1 in.	30
1 ½ in.	40
2 in.	45
2 ½ in.	50
3 in.	55
3 ½ in.	60

30

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31

Standard Method of Test for Sampling Asphalt Paving Mixtures

CDOT CP 41

1

Sampling

These methods apply to the sampling of hot mix asphalt (HMA) used for acceptance and quality control testing on CDOT projects.

2

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Key Points

- ❑Sampling is equally as important as the testing of the HMA materials
- ❑Samples must be taken properly to represent the true characteristics of the materials
- ❑Segregated materials are not to be sampled
- ❑Samples must be selected from all the material being produced via CP 75 (Stratified Random Sampling)

3

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Sampling Responsibilities

- ❑The **CONTRACTOR** performs the actual sampling of the materials
- ❑The OWNER'S AGENT (CDOT, Consultants) witnesses the sampling, and takes possession of a split sample

4

CDOT Asphalt Sample Cans

"A container with 3 to 4 gallon capacity made of at least 30-gauge non-galvanized metal, having a bail type handle and a tight-fitting lid."

5

Sampling Locations

- ❑ Method A: Plant Swing Arm
- ❑ Method B: Point of Delivery
  - ❑ Windrow Prior to Laydown
  - ❑ Paving Machine Augers
  - ❑ Roadway Prior to Compaction
- ❑ Method C: Roadway After Compaction

6

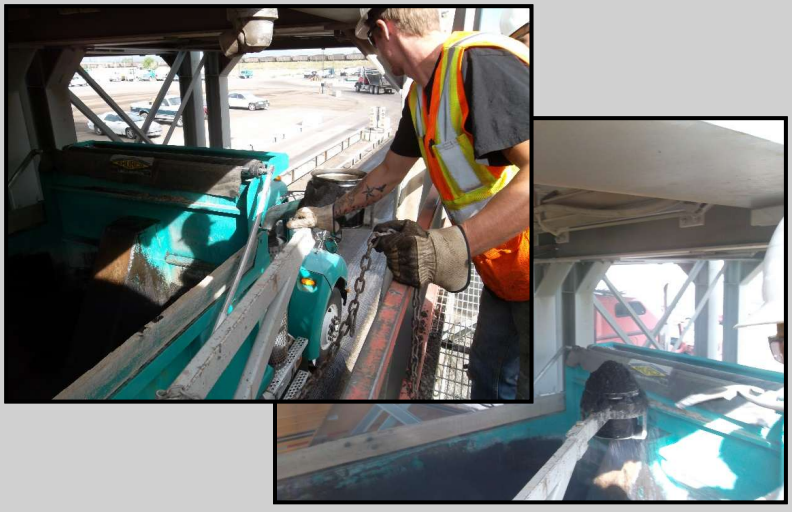
Plant Swing Arm

- The only acceptable "plant sample" method on CDOT projects
- Two methods – at the end of either, strike off the mix level with the rim of the bucket (full bucket)
  1. Swing the arm with the sample can through discharge fast enough to obtain a representative sample filling the can
  2. Prior to discharge, center can directly under discharge flow, filling the can

7

Plant Swing Arm

- **Multiple sample cans MUST be split and recombined per CP 55 before being divided between laboratories**



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Plant Swing Arm

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Point of Delivery

Windrow Prior to Laydown

10

Point of Delivery

Windrow Prior to Laydown

- ❑Remove material from one side toward the center to the full depth until a representative face is exposed
- ❑Channel the exposed face from bottom to top and place in the sample cans
- ❑Sample from at least three equally spaced locations on the exposed face
- ❑Use a flat, square end shovel, take care to not lose particles off the shovel
- ❑Combine all portions to form sample

11

Point of Delivery

Paver Augers

- ❑Paver must be **moving**
- ❑Augers should be operating at least **80 %** or more of the time.
- ❑Auger area should be **at least 2/3 covered** with mixture.

12

Point of Delivery

Paver Augers

- A clean square shovel is placed in front of the head of mix that is around the auger. If the auger is rotating the mix will flow onto the shovel

13

Point of Delivery

Paver Augers

- This video demonstrates generally ideal sampling conditions.
- Paver moving
- 2/3 auger coverage
- 80% approx. auger rotation

14

Point of Delivery

Paver Augers

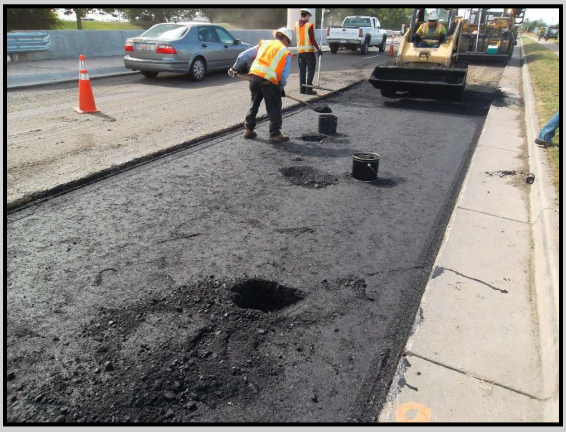
- **Multiple sample cans MUST be split and recombined per CP 55 before being divided between laboratories**

15

Point of Delivery

From the Mat

- Obtain at least 3 approximately equal size increments immediately behind the paver
- Increments shall be the full depth of lift
- Templates which are placed before mixture is laid down can be used, but are not required



16

Point of Delivery

- Multiple sample cans MUST be split and recombined per CP 55 before being divided between laboratories

17

Roadway After Compaction

Cutting Cores

- Obtain at least 3 approximate equal samples for the full depth of material, taking care to exclude any underlying material
- Each increment shall be obtained by coring, sawing or other methods in such a manner to ensure a minimum disturbance of the material

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QUESTIONS?

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Standard Method of Test for Bulk Specific Gravity and Percent Compaction of Compacted Bituminous Mixtures Using SSD Specimens

CDOT CP 44

Methods B & C

1

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BsG of Roadway Cores

- This procedure provides methods for determining **Bulk Specific Gravity** of a roadway core to calculate the percent air void analysis and relative compaction
- The Bulk Specific Gravity is also used in determining the correction factor for nuclear density gauges

2

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BsG of Roadway Cores

- **Method B** (Rapid Test for Pavement Cores)
  - Uses **HEAT** from a forced draft oven to remove moisture from the core for final weight
- **Method C** (CoreDry)
  - Uses **VACUUM** from the CoreDry machine to remove moisture from the core for final weight

3

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Core Preparation

- Avoid distortion, bending or cracking during and after removal from pavement
- Separating specimen layers should be done by sawing or suitable means
- Specimens shall be free from foreign materials such as seal coat, tack coat, foundation material, etc. and they should be stored in a "safe cool place"

4

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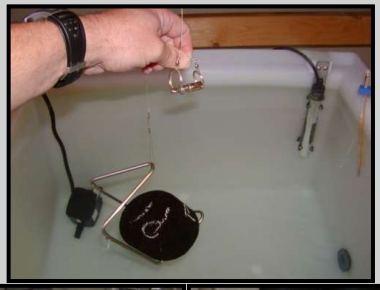
Procedure

- ❑Check water level. (Overflowing)
- ❑Check water temperature 77.0° ± 1.8°F (25 ± 1.0°C)
- ❑Zero the scale, and place core on the cradle in the water bath for the immersed mass (4 ± 1 min.) Record the mass
- ❑Remove core from water, blot with freshly wrung out, damp towel, zero the scale again, and record SSD mass



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Method B – Rapid Test

- ❑ Determine and record the weight of a pan, record mass of core and place pan and core into a forced draft oven at 230 ± 9 °F (110 ± 5 °C)
- ❑ ***OPTIONAL*** *- Leave 5 ½ inch (140 mm) or larger, or porous or wet cores in oven until they can be separated into pieces no larger than 2 inches (50 mm)*
- ❑ Dry the core for 3 hours and determine and record the mass
- ❑ Check and record the mass at 2-hour intervals until constant mass (no change of more 0.00%) or 24 hour maximum
- ❑ Cool specimen to room temperature and determine the dry mass

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Method C – Key Points

- ❑ Determine the immersed and SSD masses as in **Method B**
- ❑ This method allows for <u>cores to be saved</u>
- ❑ Tested the same day – <u>quick results</u>
- ❑ Follow procedure in 11.4 of Method C for use of CoreDry apparatus to obtain dry mass

7

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Method C – CoreDry

- ❑ Turn the CoreDry to ON position
- ❑ Allow to warm up & go through preparation cycles until "Systems Ready" prompt appears
- ❑ Allow cores to warm to room temperature & towel dry samples of free standing moisture
- ❑ Place core on its side on wire mesh in the vacuum chamber
- ❑ Make sure that moisture trap is cleaned out & place lids on vacuum chamber & moisture trap
- ❑ Press START
- ❑ CoreDry will cycle until drying is complete. If moisture is visible on core surface, clean moisture trap and run again
- ❑ Record <u>dry mass</u>

8

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Bulk Specific Gravity

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

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

9

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Percent Relative Compaction

$$\%\ \text{Comp.} = \frac{\text{Bulk Specific Gravity}}{\text{Maximum Specific Gravity (Rice)}} \times 100$$

10

Air Voids

Air Voids = 100 - % Compaction

- Air voids will always be opposite of percent compaction
- EXAMPLE: *"A core sample with a percent compaction calculated at 94.7% would have 5.3% air voids"*

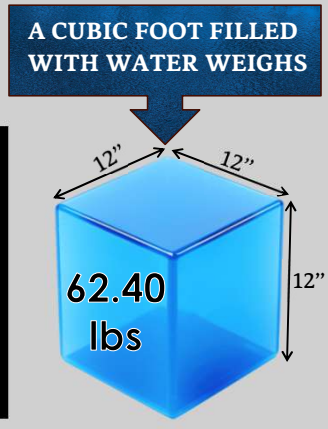
11

Specific Gravity Conversion

- Specific Gravity is a ratio expression.
- EXAMPLE: "This core sample weighs 2.397 times the weight of water occupying the same volume"
- Multiplying Specific Gravity by 62.40 provides a value expressed in PCF (pounds per cubic foot)

Specific Gravity x 62.40

Weight of Water			
	Method of Measuring Weight		
Dimensions	Pounds	Grams	Kilograms
Cubic Centimeter	0.002205	1	0.001
Cubic Inch	0.036127	16.387064	0.0163871
Liter	2.204684	1000.028	1.000028
Gallon	8.345404	3785.4118	3.7854118
Cubic Foot	62.40	28316.847	28.316847



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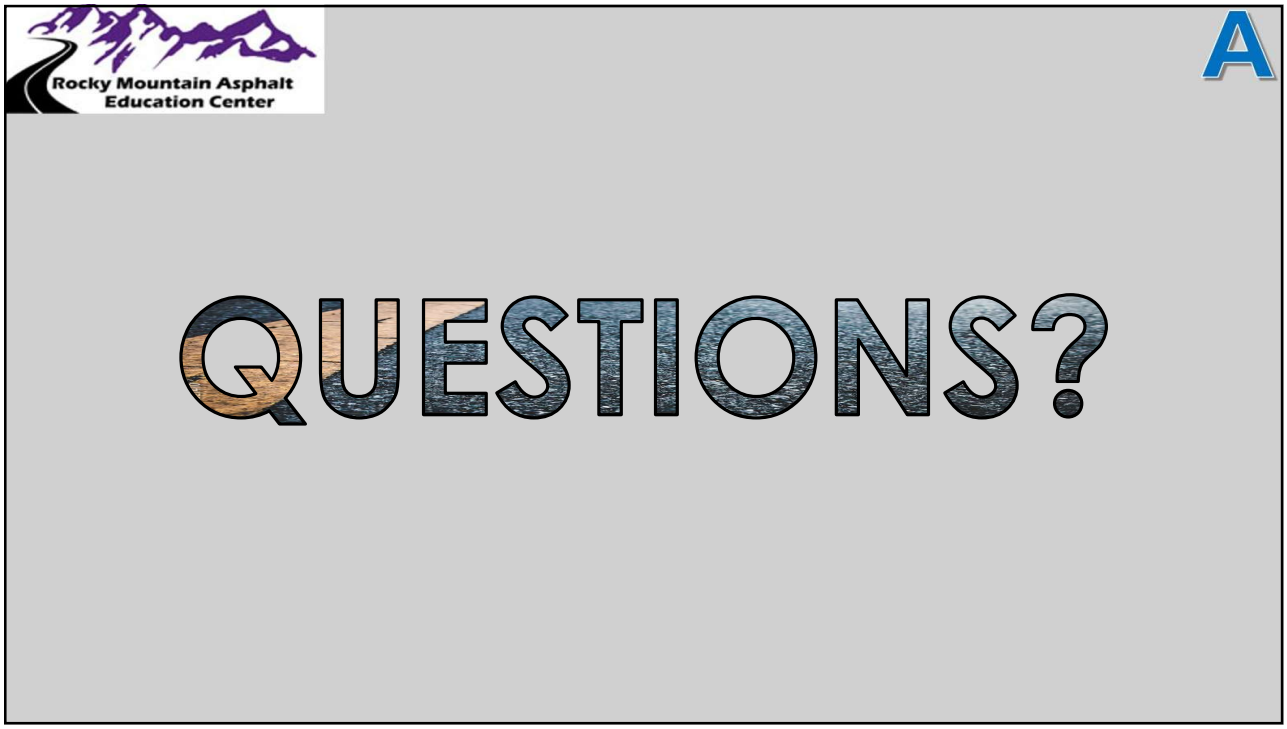

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Standard Method of Test for Density and Percent Relative Compaction of HMA Pavement by the Nuclear Method

CDOT CP 81

1

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Purpose

"For the in-place determination of density of HMA"

2

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Apparatus

- Nuclear Moisture / Density Gauge

- Standard Block

3

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A

Instrotek

4

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A

Troxler

5

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A

CPN

6

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Standardization

- Long-term aging of the radioactive source takes place in all nuclear gauges
- To offset this aging, gauges are calibrated as a ratio of the measurement count rate to a count rate made on the reference standard (standard block)

7

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Standardization

- WHEN?
  - At the start of each day
  - After the gauge has been turned off
  - When readings are in question
- WHERE?
  - "In the same environment as the actual measurement counts"
  - At least 33 ft away from other nuclear gauges
  - Clear of large masses of water, hydrogenous material, or "other items that may affect the reference count rates"

8

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Standardization

1%

- HOW?
  - Turn gauge on and allow to warm up according to the manufacturer's recommendations (20 min TROXLER and INSTROTEK, 1 min CPN)
  - Place gauge on reference standard correctly
    - TROXLER / INSTROTEK – Black handle of gauge points towards metal lip on standard block
    - CPN – Seat gauge on three raised bumps
  - Perform a 4-minute standard count and record the result
  - If the reading is not within 1% of the average of the previous 4 standards, re-run standard

9

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Procedure

- CP-75 *Stratified Random Sampling* will be used to determine the test locations
- The gauge's long axis will be parallel to the direction of the paving operation (the direction the mat was laid down)
- Test location to be minimum 6" away from vertical projections
- Test location to be a minimum 12" away from longitudinal joints and the edge of pavement

10

Procedure

- Make sure the test location is clean and level (no debris under the gauge)
- The maximum void space beneath the gauge is 1/8"
- If the test site does not meet these conditions, it may be moved slightly (a few centimeters) to ensure a suitable test location is selected
- Set the gauge to backscatter mode and mark the gauges' position on the pavement.
- Perform 2 one-minute readings – record them, and rotate the gauge 180 degrees and perform and record two additional readings

Be sure you're recording the WET DENSITY during testing

143.6
144.9

144.0
142.7

Average = 143.8 pcf

11

Calculations

- Apply the correction factor (*CP 82)* to calculate the adjusted density
  - Correction factors on nuclear gauges can be positive or negative
- Divide the adjusted density by the maximum specific gravity or RICE value (*CP-51)* to calculate percent density
  - The RICE value must be multiplied by 62.40 to convert into pounds per cubic foot (pcf)

EXAMPLE

Correction Factor = +2.7lbs
RICE = 2.492

143.8 + 2.7 = 146.5

2.492 x 62.4 = 155.5

146.5 / 155.5 = .942

.942 x 100 = 94.2%

12

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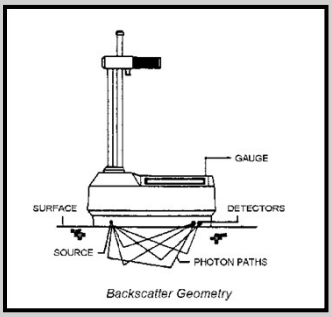
Key Points

- If total roadway thickness is less than 4 inches, underlying subgrade density variations can cause gauge test inconsistencies
- The same distances from other nuclear gauges, hydrogenous material, bodies of water etc. from the standardization process all carry over to the testing procedure
- If you cannot get your gauge standardized, it is not to be used for acceptance testing



It is often difficult to get passing readings on a 2" bottom mat!

13

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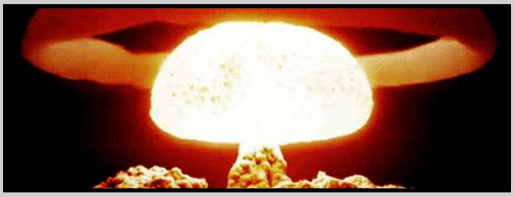
QUESTIONS?



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Compaction Test Section

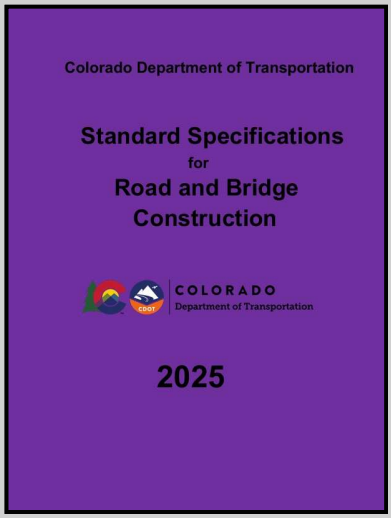
CDOT CP 82

1

Compaction Test Section

- Information about the Compaction Test Section is found in the Standard Specifications for Road & Bridge Construction, section 401.17

- Calculations for the determination of adjusted density & percent compaction of HMA are found in CP 81



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Compaction Test Section

- A section of road is constructed to determine the number and type of rollers and most effective rolling pattern to achieve the specified density
- On CDOT Projects – The test strip should be constructed using the **First 500 tons** of production
  - First 300 tons placed to determine the process
  - Last **200** tons placed to test for density correction

3

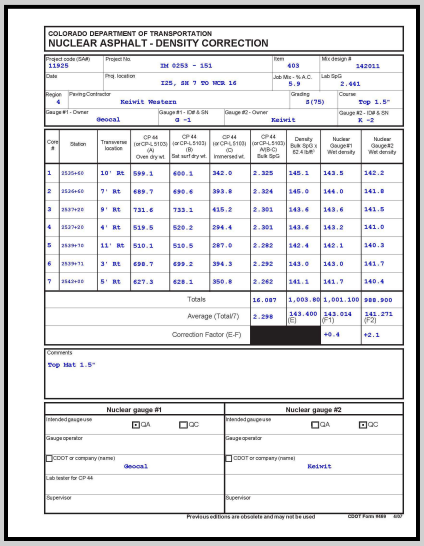
Compaction Test Section

- The contractor determines the methods and procedures to be used for the test section and all subsequent placement of asphalt mixtures for the project
- This data is recorded during the first 300 tons placed to ensure that the process is successfully established by the time the final 200 tons is placed
- Data which should be recorded, includes but not limited to:
  - Rollers - type and size
  - Speed
  - Frequency
  - Amplitude
  - Tire pressure (pneumatic rollers)
  - # of passes (static or vibratory)
  - Surface temperature of mat
  - ETC…

4

Procedure

- ❑ CDOT observes coring and testing performed by the contractor
- ❑ Perform 7 random nuclear density tests over the final 200 tons of the compaction test section (CDOT or their representative will lay out test locations)
- ❑ Contractor cuts 2 cores from the footprint of the gauge at each test location
- ❑ CDOT takes possession of one set for acceptance testing and the contractor retains the other set
- ❑ Average the wet density readings for each nuclear gauge at each of the 7 test locations
- ❑ Average the bulk specific gravities (CP 44) of each of the cores from the 7 test locations
- ❑ Compare nuclear tests to cores, derive correction factors for each gauge on the project
- ❑ Determine the acceptability of the compaction test section



COLORADO DEPARTMENT OF TRANSPORTATION
NUCLEAR ASPHALT - DENSITY CORRECTION

Project code (SAP)	Project No.		Item	Mix design #
119255	IM 0253 - 151		403	142011
Date	Proj. location		Job Mix - % A.C.	Lab SpG
	I25, SH 7 TO MCR 16		5.9	2.461
Region	Paving Contractor		Grading	Course
4	Keiwit Western		S(75)	Top 1.5"
Gauge #1 - Owner	Gauge #1 - ID# & SN	Gauge #2 - Owner	Gauge #2 - ID# & SN	
Geocal	G -1	Keiwit	K -2	

Core #	Station	Transverse location	CP 44 (or CPL-5102) (A) Oven dry wt.	CP 44 (or CPL-5102) (B) Sat surf dry wt.	CP 44 (or CPL-5103) (C) Immersed wt.	CP 44 (or CPL-5102) AVE=(D) Bulk SpG	Density Bulk SpG x 62.4 lb/ft³	Nuclear Gauge #1 Wet density	Nuclear Gauge #2 Wet density
1	2525+60	10' Rt	599.1	600.1	342.0	2.325	145.1	143.5	142.2
2	2526+60	7' Rt	689.7	690.6	393.8	2.324	145.0	144.0	141.8
3	2527+20	9' Rt	721.6	723.1	415.2	2.301	143.6	143.6	141.5
4	2527+20	4' Rt	519.5	520.2	294.4	2.301	143.6	143.2	141.0
5	2529+70	11' Rt	510.1	510.5	287.0	2.282	142.4	142.1	140.3
6	2529+71	3' Rt	698.7	699.2	394.3	2.292	143.0	143.0	141.7
7	2543+30	5' Rt	627.3	628.1	350.8	2.262	141.1	141.7	140.4
					Totals		16.067	1,003.80	1,001.100	988.900
					Average (Total/7)		2.298	143.400 (E)	143.014 (F1)	141.271 (F2)
					Correction Factor (E-F)			+0.4	+2.1

Comments
Top Mat 1.5"

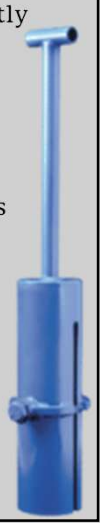
Nuclear gauge #1	Nuclear gauge #2
Intended gauge use ☒ QA ☐ QC	Intended gauge use ☐ QA ☒ QC
Gauge operator	Gauge operator
☐ CDOT or company (name) Geocal	☐ CDOT or company (name) Keiwit
Lab tester for CP 44	
Supervisor	Supervisor

Previous editions are obsolete and may not be used. CDOT Form #988 6/07

5

Procedure

- ❑ Be sure to label your cores correctly
- ❑ Cores are to be stored on their longest axis
- ❑ Do not stack cores
- ❑ Take care of the cores
  - ❑ Sunlight?
  - ❑ Weather?
  - ❑ Vibration?
  - ❑ Heat?



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Compaction Test Section

Per section 401.17 of the CDOT Standard Specification book for Road and Bridge Construction, a new CTS shall be constructed when:

- ❑A change in the compaction process (new equipment?)
- ❑Each layer of pavement (bottom mat? top mat?
- ❑Different subgrade material (base? milled surface?)
- ❑New mix design

A CTS can also be performed when nuclear gauge readings "come into question"

7

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QUESTIONS?

8