

# **FIELD COMPACTION QUALITY MANAGEMENT SYSTEM**

**Contractor Quality Control (QC)  
Asphalt Density**

- Contractor Controls Quality
  - Standard Specifications - Section 609
  
- Density Control Options
  - Core Samples or
  - Gauge Density
  
- Method and Frequency
  - Provided to Engineer by the Contractor at pre-construction conference

# Gauge Density Control . . .

- Department's [Density Gauge Operator's Manual](#) - selected to view the latest version
- Gauges allowed
  - Troxler Model 4640-B
  - Troxler Model 3450
  - PQI Model 301 (**surface mixes only**)
  - Pavetracker Model 2701-B (**surface mixes only**)

# **Gauge Density Control**

# Nuclear Gauge Requirements . . .

- Thin lift capabilities
- Printer capabilities
- Approved by the Department
- Asphalt is tested with the source rod in the “Backscatter” position
- Contractor furnishes and maintains gauge

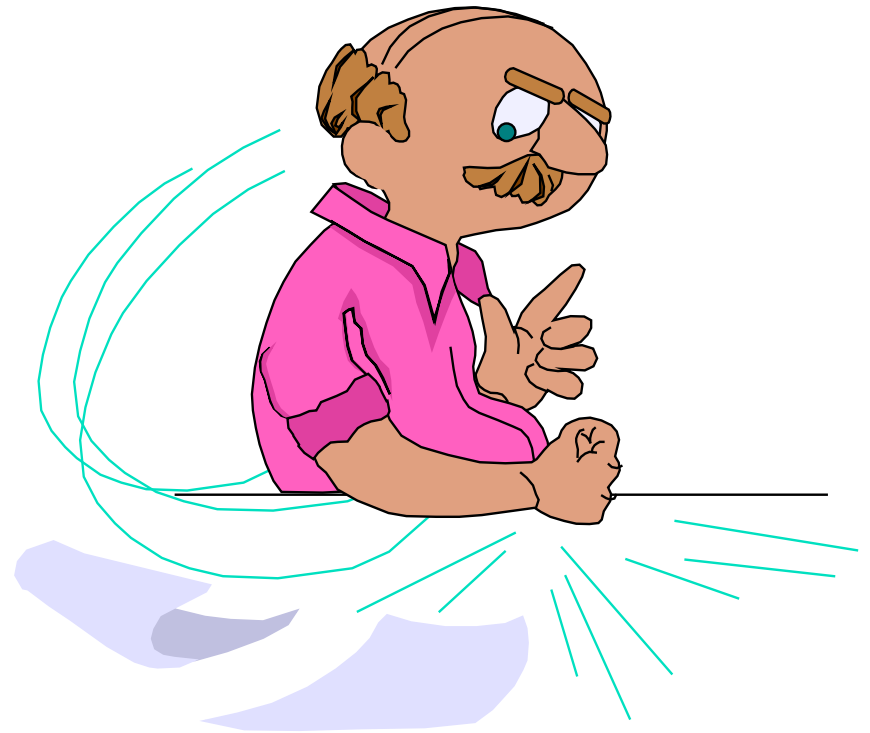
# Non-Nuclear Gauge Requirements . .

▪

- Printer capabilities
- Approved by the Department
- Contractor furnishes and maintains gauge

# Gauge Calibration Requirements . . .

- QC Gauges - calibrated by Department approved calibration service every 12 months
- QA Gauges - calibrated by M&T lab, or Department approved calibration service every 12 months
- Documentation of calibration on hand at all times



# Superpave Density Requirements

Type Mix	Maximum Specific Gravity (AASHTO T-209)
SF-9.5 A	90.0 %
B-25.0, I-19.0, S-12.5 and S-9.5	92.0 %



# Testing ...

- Contractor must maintain minimum testing frequency
- Mix without required density tests...
  - **If allowed to remain in place, will be paid for in accordance with Article 105-3 of the Standard Specifications**



# WHEN IN DOUBT?

- Better to test and accept failures than not test
- Engineer can apply Article 105-3 of Specs

- Repeated moving of gauge to “cherry pick” or find a passing density result or core site is a direct violation of procedures
- All mix shall be tested the same day that it is placed and compacted
- If density tests aren’t completed in the proper time frame...
  - production will cease at that point until required tests are completed
- QC density measurements taken with a gauge must be marked on the pavement by tracing the “foot print” of the device

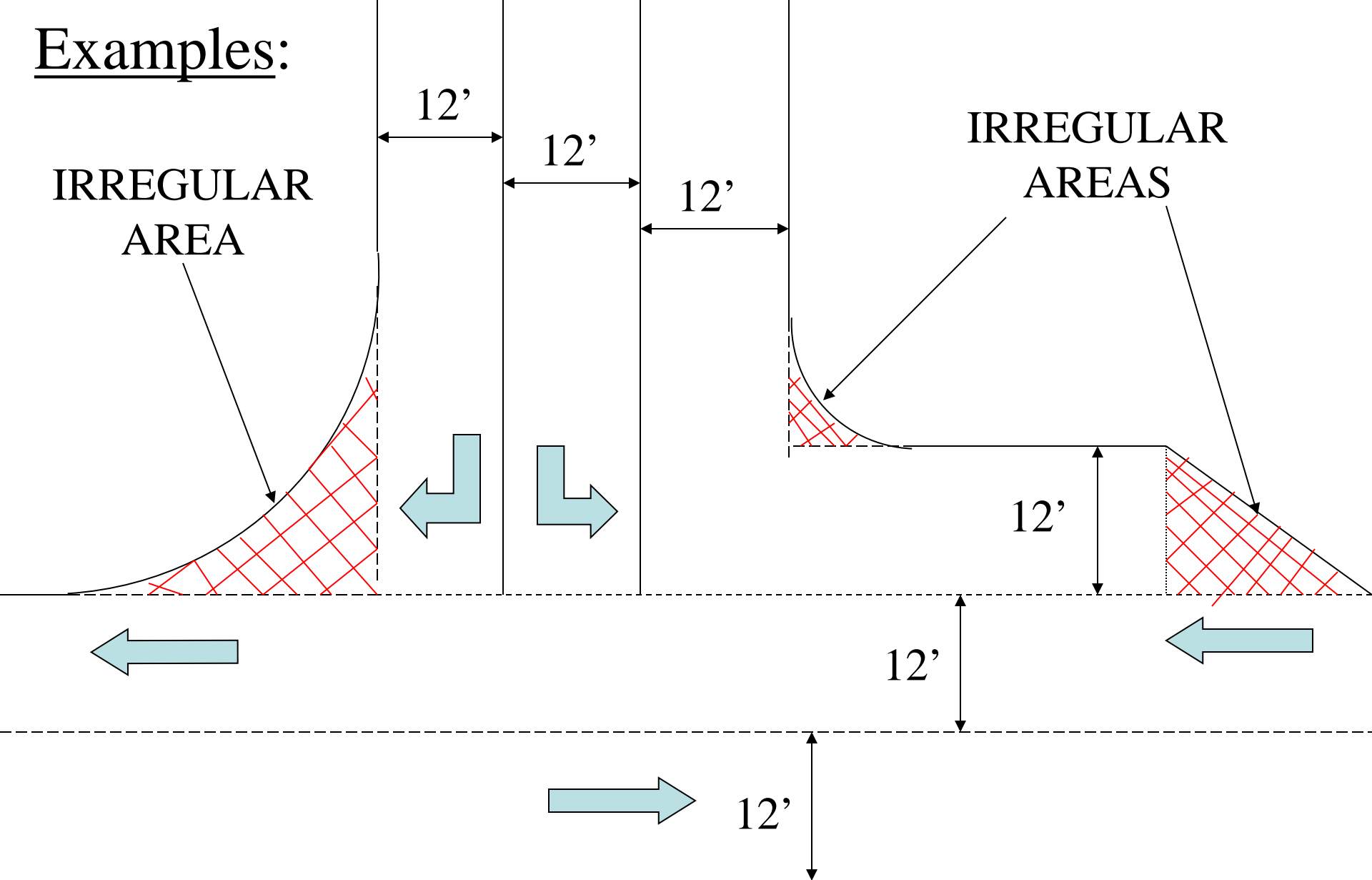
# Pavement to be tested. . .

1. Widening 4' or greater
2. Uniform paved shoulders 2' or greater
3. Full width travel lanes including:
  - Normal Mainline & -Y- Line Travel Lanes
  - -Y- Line Travel Lanes in Intersections
  - Turn Lanes
  - Collector Lanes
  - Ramps and Loops
  - Temporary Pavements

Specified density will not be required for the following provided the pavement is compacted using approved equipment and procedures . . .

1. Bases and Intermediate mixes used to widen pavements less than 4' (surface not included)
2. Any mix in an intersection that is not in a full width travel lane
3. Tapers
4. Irregular areas
5. Areas where Engineer has approved

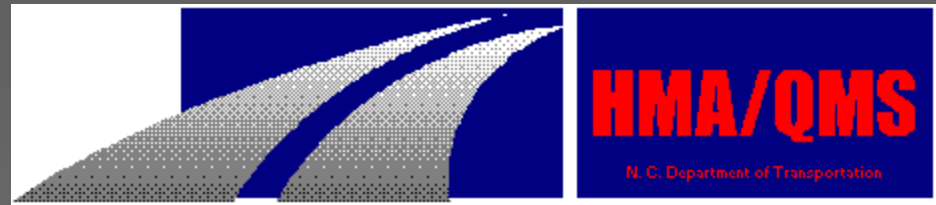
Examples:



# Quality Control Recommendations

## *Resurfacing Projects*

To aid in the final acceptance process, QC and QA (together) should evaluate existing pavement prior to the placement of new asphalt mix

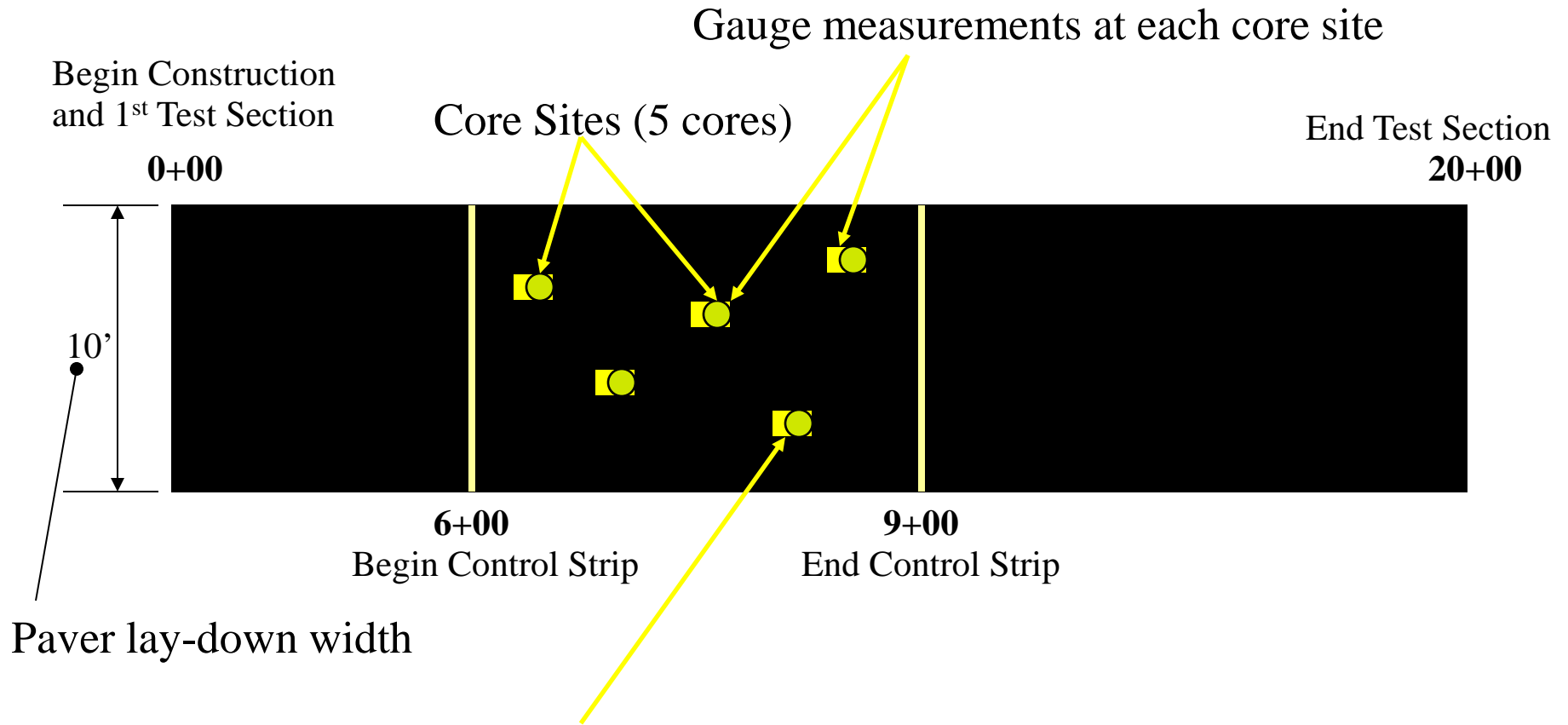


# CONTRACTOR'S CONTROL STRIP PROCEDURES (QC)



- Control Strip shall be 300 ft in length  
(may adjust length for unusual project conditions)
- Width - should be equal to lay-down width of spreader
- Depth - not greater than depth shown on plans or required by Specifications
- Engineer may determine that the roadway Control Strip can be used for the required density on shoulders

## Establish Control Strip within first Test Section



Cores shall not be located until compaction of the Control Strip is completed

## Location of Control Strips. . .

- Contractor's responsibility (roller pattern)
- Control Strip location - approved by Engineer
- Contractor shall notify Department Roadway Inspector sufficiently in advance of Control Strip placement to allow the Department to perform required QA functions

- Subgrade, base or existing roadway material on which the Control Strip is constructed must be representative of the majority of the material on which Test Sections will be constructed

# Nuclear Gauge Standard Count Procedures . . .

- Follow best practice procedures described in Appendix I
- QC Standard Count should be witnessed by a Certified QA Roadway and/or QA Gauge Operator
- QA Standard Count should be witnessed by QC Certified Gauge Operator
- If Standard Counts pass, determine the **Allowable Standard Count Range**

- Once the “Range” is calculated it is used until the next Control Strip Standard Count is performed (process is repeated)

## General Note . . .

On the day of the Control Strip, as long as the daily Standard Count passes the system 1 and system 2 requirements of the gauge, testing may be performed. The Allowable Standard Count Range requirements for system 1 and system 2 will come into affect beginning on the 2<sup>nd</sup> day of paving and will remain the same until the next Control Strip.

## Control Strip Frequency...

...shall be placed within the 1<sup>st</sup> test section of each job mix formula on each contract provided sufficient mix is produced to construct a 300 foot control strip. After the initial Control Strip, a new Control Strip shall be placed at a minimum of every 14 calendar days, also a Control Strip shall be placed for any of the following reasons:



1. Anytime one or more of the following JMF changes are made:
  - Percentage change in binder content
  - Blend change > 10%
  - Change in  $G_{mb}$  or  $G_{mm}$  on the JMF
2. Placed for each layer of mix
3. Anytime the underlying surface changes significantly
4. Different layer thickness of the same type mix when the specified thickness varies more than + or - 1/2 of an inch (12.5 millimeters)

5. Anytime the Contractor is proceeding on a limited production basis due to failing densities
6. Anytime a new or different density gauge is initially used
7. Anytime a different plant is used
8. At other times deemed necessary by the Engineer

# Numbering of Control Strips . . .

1. Number Control Strips consecutively by mix type regardless of plant furnishing, if mix is made out of a second plant, the number for the Control Strip will be followed by the suffix “A” and a third plant by “B” etc.
2. Each mix type will have a separate series of control strip numbers. Recycled and virgin mixes of the same mix type are considered the same and should be numbered consecutively

3. Passing and failing Control Strips will be numbered and reported to the Engineer
4. If a secondary gauge is used on a Control Strip for “back-up” purposes, or for a secondary crew, the secondary gauge serial number will be followed by the suffix “S”

## Control Strip Core Samples . . .

- Marked or located after completing compaction of Control Strip
- Must be numbered consecutively by mix type

For example:

When placing I- 19.0 B mix the

1<sup>ST</sup> Control Strip Core Numbers:

1QC, 2QC, 3QC, 4QC, 5QC

and

2<sup>ND</sup> Control Strip Core Number:

6QC, 7QC, 8QC, 9QC, 10QC

## Control Strip Core Samples . . .

1. Five Core Samples shall be placed in a Control Strip (if a core is damaged, follow Check Core Procedures)
2. Core Samples in the Control Strip shall be placed a minimum distance of 50 feet apart
3. Core Samples shall be located randomly across the width of the mat

Record keeping note . . .

Record core sample results at the top of  
M&T 514 QA/QC Form and QC-5 Form

# Control Strip and Core Sample Numbering Contractor Example -

**May 1 - Begin Placing: I 19.0 C**

**1<sup>ST</sup> Control Strip: 1 QC**

**Core Numbers: 1QC, 2QC, 3QC,  
4QC, 5QC**

**May 15 - (14 calendar day requirement)**

**2<sup>ND</sup> Control Strip: 2 QC**

**Core Numbers: 6QC, 7QC, 8QC,  
9QC, 10QC**



**May 21 (different plant used)**

**3<sup>RD</sup> Control Strip:**

**3 AQC**

**Core Numbers:**

**11QC, 12QC, 13QC,  
14QC, 15QC**

# Numbering Control Strip and Core Samples Contractor Example (same project) -

**July 11 - Begin placing: S 12.5 B**

**1<sup>ST</sup> Control Strip: 1 QC**

**Core Numbers: 1QC , 2QC, 3QC,  
4QC, 5QC**

**July 25 – (14 calendar day requirement)**

**2<sup>ND</sup> Control Strip: 2 QC**

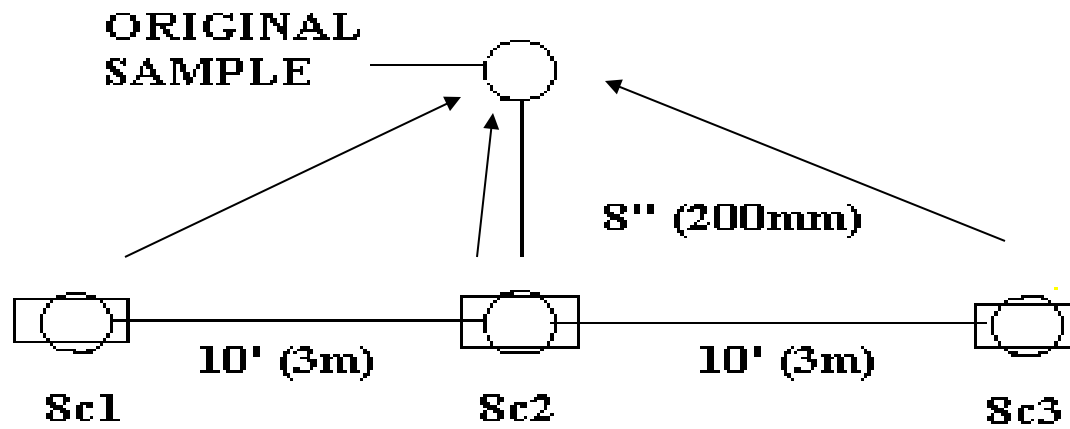
**Core Numbers: 6QC, 7QC, 8QC,  
9QC, 10QC**

# Check Core Sample Procedures . . . .

- May be taken by Contractor . . . .
  - When a core sample is **damaged**.
  - When a control strip **fails** and a core sample is more than 2.0% below the average of the control strip core average.

# Gauge Density Readings for Check Cores...

- If Check Core Samples are taken from a density gauge control strip :
  - Take two nuclear gauge readings or 5 non-nuclear gauge readings on top of each new core location
  - The average of gauge readings will replace each of the original readings for the core in question



# Core Check Samples .

- 3 additional cores must be cut **WITHIN 2 DAYS**
- **Only 1 set** of check samples per sample location and the average results will be used in lieu of the original sample results
- **Must** be taken in the presence of a representative of the Engineer

# Retention of Control Strip Core Samples . . .

Contractor's Control Strip Core Samples shall be retained for 5 calendar days at the plant site, or until disposal permission is granted by the QA personnel, whichever occurs first

**The QA personnel will retest 100% of the Control Strip Cores**

The Department's comparison Quality Assurance Core Samples shall be retained in a sealed container at the plant site until obtained by QA personnel

- All retained samples shall be stored on a smooth, flat surface, in a cool, dry protected location.

# QC Target Density . . .

- After completing compaction of the Control Strip, obtain density gauge measurements at each of the 5 core sites
- The average density of the Control Strip Core Samples shall be at least equal to the minimum density specified for the mix based on the maximum specific gravity



## Calculated Target Density . . .

1. Prior to opening the section to traffic or no later than the beginning of the next day following completion of the Control Strip, the Contractor shall core the five samples.
  - The QC Laboratory will determine density.
  - Artificial cooling of the cores is permitted however, no compensation

2. Until results of the Control Strip are determined, paving may continue. Evaluation will be based on the Calculated Target Density determined by:

$$62.4 \text{ pcf} \times G_{mm} = XXX.X \text{ (pcf)}$$

Where:

62.4 = Unit Weight of Water

$G_{mm}$  = QC Mix Verification Max. Specific Gravity

Note!

Should an acceptable correlated Target Density not be established Density Acceptance will be based on the Calculated Target Density unless the Contractor elects to cut cores

3. If the average density of the 5 cored samples is at least equal to the minimum density specified for the mix, the Control Strip is considered valid and paving may continue in the normal manner

4. If the average density of the 5 core samples fails to meet the minimum density, the Contractor shall construct a new Control Strip (must meet all Provisions)
  
5. If the second Control Strip fails, the Contractor is placed on Density Limited Production Procedures

6. Check samples may be taken on any Control Strip Core Samples, but must be in accordance with Article 609-7(A) of the Specifications.
- If check samples are taken, gauge readings must be taken at each of the 3 core sites.
  - The average of these readings will replace the initial readings.
  - A new Target Density will be determined using the new core sample average and the new density gauge readings.

7. Once the Correlated Target Density is established, it will be used to determine Density Acceptance until another passing Control Strip is placed and a new Target Density is determined.

8. If more than 17 calendar days have lapsed since last using a Correlated Target Density, the procedures for obtaining a new Correlated Target Density shall be followed. However . . .

- The current Maximum Specific Gravity moving average will be utilized to determine the calculated Target Density

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
CONTROL STRIP DENSITY

Rev. 02/11

**Work Problem -  
Control Strip**

Date: 4/4/12  
 Contract/Project No. C200000 County Wake Control Strip No. 1 QC  
 From Sta. 5+50 to Sta. 8+50 Lane NBL Lt  
 Layer 1 st Depth 2.00" Width 6' Route US-1 Job Mix Formula 12-0432-151  
 Gauge Serial No. 1817 Material S 9.5 B Crew No. 1

STANDARD COUNTS		ASPHALT CORE SAMPLES	
Density		Core No.	Sta.
<u>5261</u> System 1			%Compaction
<u>1877</u> System 2		—	<u>93.1</u> %
		—	<u>92.7</u> %
<u>5314</u> Allowable Standard Count Range	<u>5208</u>	—	<u>92.4</u> %
+1.0% System 1 -1.0%		—	<u>92.5</u> %
<u>1900</u> +1.2% System 2 -1.2%	<u>1854</u>	—	<u>93.0</u> %
			Avg. % Compaction <u>92.7</u> % (A)

Test	Station	ASPHALT (Wet Density)
1	—	<u>144.7</u>
2	—	<u>144.2</u>
3	—	<u>144.1</u>
4	—	<u>144.5</u>
5	—	<u>143.9</u>
6	—	<u>143.7</u>
7	—	<u>142.9</u>
8	—	<u>143.4</u>
9	—	<u>144.8</u>
10	—	<u>144.4</u>
AVG. (PCF)		<u>144.1</u> (B)
ASPHALT TARGET DENSITY <u>155.4</u>		
Average of Control Strip (PCF) + Average of Cores (B+A) 100 = <u>155.4</u> (C) Target Density (PCF)		
A = Core Sample Average B = Average PCF of Control Strip C = Correlated Target Density		

cc: \*Resident Engineer [White] \*QA Copy Only  
QA/QC Technician [Gold]

Print Name Legibly w/ HiCAMS #: IM Goode 12345

QA/QC Technician Signature: IM Goode

NOTE: By providing this data under my signature and/or HiCAMS certification number, I attest to the accuracy and validity of the data contained on this form and certify that no deliberate misrepresentation of test results, in any manner, has occurred.



To ensure understanding, please complete the following questions.

You must score 80% or better to complete the on-line portion of this training course.

Repeated moving of a density gauge to "cherry pick" or find a passing test site or core site could be considered falsification.

- A) True
- B) False

Correct - Click anywhere to continue

Incorrect - Click anywhere to continue

You must answer the question before continuing

Submit

Clear

Unless otherwise specified, what is the minimum density requirement for an I-19.0 mix?

- A) 89.0%
- B) 90.0%
- C) 92.0%
- D) 95.0%

Correct - Click anywhere to continue

Incorrect - Click anywhere to continue

You must answer the question before continuing

Submit

Clear

Nuclear density measurements must be taken with the source rod in the \_\_\_\_\_ position?

- A) Backscatter
- B) 4 inch direct transmission
- C) 2 inch direct transmission
- D) None of the above

Correct - Click anywhere to continue

Incorrect - Click anywhere to continue

You must answer the question before continuing

Submit

Clear

Asphalt should be tested the same day  
it is placed and compacted.

- A) True
- B) False

Correct - Click anywhere to  
continue

Incorrect - Click anywhere to  
continue

You must answer the question  
before continuing

Submit

Clear

# Which of the following JMF changes would require that a new Control Strip be placed.

- A) Any percentage change in binder content
- B) An aggregate blend change in excess of +/- 10%
- C) Any change in Gmb or Gmm on the JMF
- D) All of the above

Correct - Click anywhere to continue

Incorrect - Click anywhere to continue

You must answer the question before continuing

Submit

Clear

If the average of the 5 cores fails to meet the minimum requirements the Contractor is to construct a second Control Strip?

- A) True
- B) False

Correct - Click anywhere to continue

Incorrect - Click anywhere to continue

You must answer the question before continuing

Submit

Clear

# Quiz

<b>Questions Correct</b>	{correct-questions}
<b>Total Questions</b>	{total-questions}
<b>Accuracy</b>	{percent}
<b>Number of Quiz Attempts</b>	{total-attempts}

Question Feedback/Review Information Will Appear Here

Continue



# Congratulations!

You have now completed course:

*QMS Density Gauge Online Course - Segment 2*

Please click the following link and fill out the form to receive credit for completing this course.

[Acknowledgement Form](#)