Chapter 5

2009

Overview

All sampling and testing of HMA materials is performed at the frequency and by procedures specified in the specification. If not specified, the latest AASHTO and ASTM specifications available at time of bid govern when performing sampling and testing for acceptance. AASHTO and ASTM test modifications are listed in Table M.04.03-6 of the specification.

5.01 Performance Graded (PG) Asphalt Binder

Scope: This section covers Performance Grade asphalt binders. PG binder suppliers must comply with the annual "Requirements for Annual Submission of Quality Control Plan, AASHTO R-26(M) and as modified in Table M.04.03-6 of the specification.

Requirements: The Contractor shall submit a Certified Test Report and bill of lading representing each delivery in accordance with AASHTO R-26(M). Upon material delivery, contractor plant personnel shall record lot number, date, grade of binder, witnessed by, hauler name, liquid supplier, ticket number, receiving storage tank number, quantity received and previous tank status(quantity) in the binder log (Form 435) provided by the State of Connecticut. The Contractor shall provide binder samples at the request of the Division Chief of Research and Materials (DC).

Sampling: AASHTO T 40(M): Sampling Bituminous Materials
Procedure: the following standard methods of test:

1. AASHTO T 44: Solubility of Bituminous Materials
2. AASHTO T 48: Flash and Fire Points by Cleveland Open Cup
3. AASHTO T 228: Specific Gravity of Semi-Solid Bituminous Materials
4. AASHTO T 240: Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin Film Oven Test)
5. AASHTO T 313: Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
6. AASHTO T 314: Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)
7. AASHTO T 315: Determining the Rheological Properties of Asphalt Binder Using the Dynamic Shear Rheometer (DSR)
8. AASHTO T 316: Viscosity Determination of Asphalt Binder Using Rotational Viscometer (RT)
9. AASHTO R 28: Accelerated Aging of Asphalt Binder Using a Pressure Aging Vessel (PAV)
10. AASHTO R 29: Grading or Verifying the Performance grade of an Asphalt Binder

Report: Form MAT 401

5.02 Cut-Back Asphalts

Scope: These methods of test cover liquid petroleum products, produced by fluxing an asphaltic base with suitable light volatile solvents or distillates, to be used in the treatment of road surfaces.

Sampling: AASHTO T 40(M): Sampling Bituminous Materials

Procedure: the following standard methods:

1. AASHTO T 79: Flash Point with Tag Open Cup Apparatus for Use with Material having a Flash Less than 200°F (93.3°C)
2. AASHTO T 201: Kinematic Viscosity of Asphalts
3. AASHTO T 227: Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
4. AASHTO T 78: Distillation of Cutback Asphaltic Products
   - 4.1 AASHTO T 49: Penetration of Bituminous Materials
   - 4.2 AASHTO T 202: Viscosity of Asphalts by Vacuum Capillary Viscometer

Report: Form MAT-400

5.03 Damproofing

Scope: This section covers three asbestos-free asphalt roof coatings of brushing or spraying consistency suitable for use as waterproofing and damp proofing of concrete and concrete masonry.

Sampling: AASHTO T 40(M): Sampling Bituminous Materials

Procedure: the following standard methods:

1. AASHTO T 49: Penetration of Bituminous Materials
2. ASTM D 95: Moisture, percent
3. ASTM D 4479: Nonvolatile Matter, percent
4. AASHTO T 72: Saybolt Viscosity
5. AASHTO T 78: Distillation of Cutback Asphaltic Products

Report: Form MAT 315

5.04 Emulsified Asphalt

Scope: These methods of test cover asphalt emulsions composed principally of a semisolid liquid asphaltic base, water, and an emulsifying agent. Sampling and testing for this item must be from Terminal and refinery sources of supply and from project tanker trucks when used as tack coat, emulsion for chip seal pavements, and specialty mixes.

Sampling: AASHTO T 40(M): Sampling Bituminous Materials

Procedure: AASHTO T 59: Testing Emulsified Asphalt

Report: Form MAT 402

5.05 Recovery of Asphalt Binder for HMA Materials

Scope: This section covers the recovery of asphalt from a previously conducted extraction with reagent-grade trichloroethylene. The asphalt is recovered with properties substantially the same as those it possessed in the asphalt mixture and in quantity sufficient for testing. Sampling and testing for this item must be from newly mixed (virgin) HMA or materials that contain RAP; HMA stored in silos, from paver hoppers, pavement during lay down, and from roadway materials.

Sampling: AASHTO T 40(M): Sampling Bituminous Materials

Procedure: the following standard methods:

1. AASHTO T 164 (M): Quantitative Extraction of Bitumen from Bituminous paving Mixtures
2. AASHTO T 170 (M): Recovery of Asphalt from Solution by Abson Method
    - 2.1 AASHTO T 202: Viscosity of Asphalts by Vacuum Capillary Viscometer
    - 2.2 AASHTO T 315: Determining the Rheological Properties of Asphalt Binder Using the Dynamic Shear Rheometer (DSR)
    - 2.3 AASHTO R 29: Grading or Verifying the Performance Grade of an Asphalt Binder

Report: Form MAT 423

5.06 Hot Poured Sealers for PC Concrete and Asphalt Pavements

Scope: This section covers joint sealants of the hot poured type intended for use in Portland cement concrete and asphalt concrete pavements.

Sampling: AASHTO T 40(M): Sampling Bituminous Materials

Procedure: ASTM D 5329

Report: Form MAT 424

5.07 & 5.08 VACANT

5.09 Asphaltic Plug Joint

Scope: This section covers the components, testing, and application requirements for field molded asphaltic plug material used within expansion joints on bridges with asphalt concrete overlays or PC concrete decks.

Sampling: AASHTO T 40(M)

Procedure: ASTM D 6297 Table 1 and special provision

1. Thermoplastic Polymeric-modified asphalt binder per manufacturer specifications
2. Aggregate per manufacturer specifications
3. Foam expansion joint filler per manufacturer specifications
4. Steel bridge plate per manufacturer specifications

Report: Form MAT 315

5.10 Quantitative Extraction of Binder from HMA

Scope: Determination of the percentage of bitumen in a paving mixture. It is not intended for use in recovering the bitumen for further testing. The aggregate and mineral matter recovered from this test is used for sieve analysis.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures
Procedure: AASHTO T 164 Method A (M). The ash correction Article 11.6.1

Report: MAT 412, MAT 412S or MAT 413. Ash results are reported on Form MAT 422.

5.10.1 Binder Content by Ignition Method for HMA

Scope: This method of test is intended for the determination of the total percentage of bitumen in HMA mixtures. Aggregate calibration for each type of mixture will be provided by the DC or may be submitted by the contractor for use during production.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures, AASHTO T 328 (M).
Procedure: AASHTO T 308(M), AASHTO T 328(M) Reducing Samples of HMA to Testing Size
Report: Form MAT 412, MAT 412S or MAT 413

5.10.2 Correlation Between Production Pull & Binder Content by Ignition Method

Scope: Total binder content of the mix as determined by the asphalt plant batching system, and the test result determined by the ignition oven, is no more than 0.2% different. The moisture content in the mix may be used to adjust the binder content determined by the ignition oven.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures, AASHTO T 328 (M).

Procedure: AASHTO T 308(M) Asphalt Binder Content of HMA by Ignition Method
AASHTO T 329(M): Moisture Content of Hot Mix Asphalt by Oven Method
AASHTO T 328(M) Reducing Samples of HMA to Testing Size

Report: Form MAT 412, MAT 412S or MAT 413

5.11 Mechanical Analysis of Extracted Aggregate

Scope: This method of test covers a procedure for the determination of the particle size distribution of fine and coarse aggregates extracted from HMA mixtures using sieves with square openings.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures, AASHTO T 328 (M).

Procedure: AASHTO T 30 (M), AASHTO T 328 (M) Reducing Samples of HMA to Testing Size

Report: Form MAT 412, MAT 412S or MAT 413

5.12 Resistance to Plastic Flow of Hot Mix Asphalt Mixtures

Scope: This method of test determines of the stability and flow of Hot Mix Asphalt paving mixtures using Marshall Mold Specimens

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures, AASHTO T 328 (M).

Procedure: AASHTO T 245 (M): Resistance to Plastic Flow of Bit. Mixture Using Marshall Apparatus

AASHTO T 328 (M) Reducing Samples of HMA to Testing Size

Report: Form MAT 412

5.13 Bulk Specific Gravity of Compacted HMA Mixtures

Scope: This method determines of the bulk specific gravity of compacted HMA mixtures.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures, AASHTO T 328 (M).

Procedure: AASHTO T 166 (M): Bulk Specific Gravity of Compacted Asphalt

Mixtures Using Saturated-Surface Dry Specimens

AASHTO T 328 (M) Reducing Samples of HMA to Testing Size

Report: Form MAT 412 or Form MAT 412S

5.14 Maximum Specific Gravity of HMA Paving Mixtures

Scope: Determination of the maximum specific gravity of uncompacted HMA paving mixtures.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures, AASHTO T 328 (M).

Procedure: AASHTO T 209 (M): Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

1. Use of potable water in place of distilled water as stated in T 209 (M)
2. Water bath temperature correction not utilized
3. Use of digital manometers used in place of mercury manometers
4. Bowl submerged in water bath until scale weight is at a constant, use of 10 +/- 1 minute specification not invoked

Report: Form MAT 412 or Form MAT 412S

5.15 Sampling HMA Paving Mixtures

Scope: Procedures for sampling mixtures of HMA material with mineral aggregate.

Sampling: AASHTO T 168 (M): Sampling Bituminous Paving Mixtures

Procedure: AASHTO M 323: Superpave Volumetric Design Method, AASHTO T 328 (M).

Sampling and testing is required to be performed by a NETTCP certified technician. The sample from the transport vehicle can be taken from one location as specified in AASHTO T 168-3 section 5.2.2. The technician or their representative may scoop all HMA mixtures from the sample container with the exception of 25.0 mm and Class- 4 mixes. The contractor technician, or their representative shall arrive a minimum of one hour in advance of any production to test component moisture and gradation properties, power on and preheat laboratory equipment, and prepare PC and test forms.

Report: Form MAT 412 or Form MAT 412S

5.16 Preparation of Marshall Mold Specimens

Scope: These methods cover the preparation of test specimens using Marshall Apparatus in conformance with procedures specified in AASHTO R-12.

Sampling: AASHTO T 168 (M), AASHTO T 328 (M).

Procedure: AASHTO T 245 (M).

1. for production testing: One specimen is molded for each extraction test for production over 275 Tons per day.

Report: Form MAT 412

5.16.1 Preparation of Gyratory Specimens

Scope: These methods cover the preparation of test specimens using the gyratory compactor. Each apparatus must be calibrated, maintained and serviced per the manufacturer's recommendations.

Sampling: AASHTO T-168 (M), AASHTO T 328 (M).

Procedure: AASHTO M 323: Superpave Volumetric Mix Design
AASHTO R 35(M): Superpave Volumetric Design for Hot Mix Asphalt
AASHTO T 329(M): Moisture Content of Hot Mix Asphalt by Oven Method
AASHTO T 312(M): Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

Testing of HMA materials, fabrication of gyratory molds, theoretical, and liquid content, must be started and fabricated within 1/2 hour from the time of sampling from the delivery truck, and be completely finished within 2 hours. Physical, Volumetric and other properties will be calculated in accordance with the contract specifications and AASHTO M 323 and R 35(M).

5.17 Production Inspection at Hot Mix Asphalt Plants

Scope: The purpose of production inspection is not only to check on the operations of the Contractor for compliance to the specifications, but also to assure that the Contractor is exercising adequate quality control to maintain compliance. The Contractor must maintain a certain degree of uniformity not only daily but also throughout the life of the contract. The aggregate in each stockpile must be of uniform quality and gradation; the materials must be fed into the plant in a uniform, controlled manner; the heating and drying of the aggregates must be uniform; the separation of the aggregates into their various bin sizes must be uniformly controlled; and the aggregates and the asphalt cement must be combined and mixed in a uniform, consistent manner.

Sampling: section 5.15 and 5.18

Procedure: contract specifications and Form MAT 430

Production inspection at the HMA plant is divided into four main categories:

1. **Process Control (PC):** Performed by the HMA producer prior to production and shipment
2. **Quality Control (QC):** The sum total of activities performed by the seller (producer, manufacture, contractors) to make sure that a product meets contract specification requirements.
3. **Acceptance System (Acceptance/Verification Plan)** – All factors that comprise the Agency's determination of degree of compliance with contract requirements and value of a product. These factors include Agency sampling, testing, acceptance limits, risk, operating characteristics and inspection. These factors should also include validated results of contractor sampling and testing.
4. **Independent Assurance (IA):** IA is an unbiased and independent verification of the Quality Assurance system used as a method of determining the reliability of the test results obtained in the regular sampling and testing activities. The results of IA tests are not to be used as a basis of material Acceptance/Verification.

Report: FORM 412, MAT 413, and MAT 412S

5.17.1 Vacant

5.17.2 HMA Verification Testing Procedures

Scope: Verification (V) testing will be performed by the DC at an approximate frequency of (1 to 10) to the Contractor QC testing. V samples must be obtained by Department personnel from the same material sampled by the Contractor QC or their representative. Testing of this material will be performed at the Department's Central Laboratory and the results compared to Contractor results. If all delta limits listed in column C of Table 1 are not exceeded, the Contractor results will be considered valid.

Should any delta limit in column C be exceeded, the Contractor's Quality Control manager will be notified, and an investigation will be immediately initiated by the DMT to determine the assignable cause. This investigation will be conducted by the DMT's Independent Assurance (IA) section. The investigation could include the following:

-Split samples between IA and Contractor personnel
-Split samples between IA and DMT verification personnel
-Proficiency samples performed at Contractor facility
-Recalibration of testing equipment

Assignable cause may be one of the following:
- Improper testing procedure.
- Faulty equipment or improper calibration
- Misreporting of test results

Pending the results of this investigation, the Contractor data may be declared invalid. In this case, additional Verification test may be performed by the DMT on material produced on the date in question. All invalid Contractor data for that days' production will be replaced by results from standard verification testing and any additional testing performed by DMT. The Engineer may replace the entire days' testing results with a single result from verification testing for payment purposes. The Engineer will determine how much additional testing is required.

If it is determined that Contractor data is invalid due to misreporting of test results, NETTCP will be notified as to the results of the investigation, and the technician(s) involved in the testing will be put on probation by the DMT for the entire construction season. Should a pattern of invalidated test results be established as determined by the Engineer, the technician will be prohibited from testing materials for Department use until NETTCP investigates the technician further and determines that his/her certification is still warranted. Until this determination is made, the Contractor must provide another NETTCP certified technician at the plant to produce material for the Department.

Sampling: QC samples and non-witnessed QC samples may be tested by the DMT.

Procedure: the following standard methods:

1. AASHTO T-308 (M) Determining the Asphalt Content of HMA by the Ignition Method.
2. AASHTO T-30 (M) Mechanical Analysis of Extracted Aggregate.
3. AASHTO T-209 (M) Theoretical Maximum Specific Gravity & Density of Bit. Paving Mixtures.
4. AASHTO T-166 (M) Bulk Specific Gravity of Compacted Asphalt Mixtures using Saturated Surface-Dry Specimens.
5. AASHTO T-164 (M) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.

TABLE 1: VERIFICATION & ACCEPTANCE LIMITS
Columns A and B are used for internal ranking purposes.

	A	B	C	D
Properties	**(Delta X 0.25)**	**(Delta X 0.5)**	**Delta |QC-QA|**	**(>Delta)**
#200	0.18	0.35	0.7	> 0.7
#100	0.5	1.0	2.0	> 2.0
#50	0.5	1.0	2.0	> 2.0
#30	0.5	1.0	2.0	> 2.0
#16	0.5	1.0	2.0	> 2.0
#8	0.5	1.0	3.0	> 3.0
#4	0.5	1.0	3.0	> 3.0
3/8”	1.0	2.0	4.0	> 4.0
1/2”	1.0	2.0	4.0	> 4.0
3/4”	1.0	2.0	4.0	> 4.0
1”	1.0	2.0	4.0	> 4.0
1 1/2”	1.0	2.0	4.0	> 4.0
2”	1.0	2.0	4.0	> 4.0
Pb	0.06	0.12	0.25	> 0.25
Va	0.18	0.35	0.71	> 0.71
VMA	0.18	0.35	0.71	> 0.71
VFA	3.5	3.5	3.5	> 3.5
Gmm	0.005	0.009	0.018	> 0.018
Gmb	0.003	0.006	0.011	> 0.011
Pbe	0.06	0.12	0.25	> 0.25
Pba	0.06	0.12	0.25	> 0.25
PD@Ni	0.18	0.35	0.71	> 0.71
PD@Nd	0.18	0.35	0.71	> 0.71
PD@Nm	0.18	0.35	0.71	> 0.71
Gse	0.005	0.009	0.018	> 0.018
#200/Pbe	0.03	0.07	0.15	> 0.15
Masses(% of total mass)	0.025	0.05	0.1	> 0.1
Heights (average of 4) (mm of final height)	0.5	1.0	2.0	> 2.0

5.18 Duties of The HMA Plant Inspector

Scope: The inspection will consist of checking the quality of materials in the stockpile, cold bins, and hot bins when required; inspection of processing, sampling; and testing the finished product for conformance to the specifications. The duties listed here are sample requirements to be performed by all types of Inspectors (i.e., PC, QC, (A), and IA). The responsibilities of a HMA inspector will include but are not limited to that shown in Form MAT 431.

Sampling: contract specification.
Procedure: contract specifications and Form MAT 432.
Report: FORM MAT 412, MAT 413, MAT 412S and Daily Inspector Report /Form MAT 431.

5.19 Degree of Particle Coating of HMA Mixtures

Scope: This test is intended to determine the degree of coating of coarse particles of aggregate in a HMA mixture in relation to the wet mixing time. When HMA is mixed, coarse particles of aggregate are the last and the most difficult to coat, and their coating may be a measure of mixing effectiveness.

Sampling: AASHTO T 195 (M) and T 168 (M).

Procedure: AASHTO T 195 (M).

1. Only one truck load of mixture is sampled.
2. Sample is taken from opposite sides of the load.

Report: Form MAT 412 or MAT 412S.

5.20 Annual Qualification of Hot Mix Asphalt Plants

Scope: This section covers requirements for qualifying facilities for the production of hot-mixed asphalt paving mixtures for use on Department projects annually or more frequently, as needed. Materials, technicians, mix designs, and the maintenance of calibration and test records must meet the contract specifications. The DC reserves the right to perform random spot inspections on any of the above items during the productions season.

Sampling: Sampling of materials and equipment will be done during site inspection by Department personnel.

Procedure: Hot Mix Asphalt plants are inspected annually during the spring season Form MAT 404 for Batch plants and Form MAT 405 for Drum Plants.

Specifications: Approval criteria for HMA Plants will be in accordance with AASHTO M 156(M) for a Batch Plant or a Drum Dryer Mixer Plant and contract specifications.

Report: Form 404 for Batch Plants and Form 405 for Drum plants

5.20.1 - HMA Plant Field Testing Laboratory

Scope: The Contractor shall furnish a field laboratory meeting the requirements of Section M.04.01-8(f) and have it approved by the DC prior to any production.

Report: Results of inspection will be reported on:

1. FORM MAT-404 - Check List for HMA Plants (batch type)
2. FORM MAT-405 - Check List for HMA plants (drum type)
3. FORM MAT-406 - Field Laboratory Apparatus Inspection Sheet
4. FORM MAT-407 – Deficiency Form
5. FORM MAT-415 – HMA guideline for sampling platform stand

5.21 Hot Mix Asphalt Production - Request for Test

Scope: Production and placement of Hot Mix Asphalt is unique in that mixtures must be tested during manufacture and placement and both are weather dependent. Consequently, testing personnel may be notified of upcoming paving operations with as little as 12 hours notice. It is imperative that project personnel provide notification to the Division of Materials Testing as soon as possible. Forms MAT 420 (District Construction) and MAT 421 (Maintenance) are guidelines for project personnel regarding HMA testing. The Division of Materials Testing typically sends these forms to projects in March of each year.

Procedure: Site Manager Procedures Manual

Report: MAT 100

5.22 HMA Inspection Personnel Assignment Procedure

Scope: A priority system is utilized in assigning Hot Mix Asphalt plant inspectors, employing a review of computer-generated records of past plant performance, as well as first hand knowledge of recent plant performance and testing results. This priority system analyzes all test data on a daily basis, and rates the plants according to past performance data. This information assists in prioritizing daily assignment of HMA inspectors to bituminous plants based on the following:

- **Poor performance**
- **Daily tonnage produced**
- **Random sampling**

The ability of a bituminous plant to produce a consistent uniform product, meeting specifications 70% of the time or more, entitles that plant to an “A” rating and may reduce the inspection frequency.

5.22.1 VACANT

5.22.2 Mix Design Submittal and JMF Change Procedure

Scope: Each Plant must have each type of HMA material evaluated daily based on the current production specification for the purpose of establishing a ranking for that type. Based on the ranking a type receives must determine whether the material can be shipped un-interrupted or the plant ceases supply. Upon receiving one of these designations, the contractor may be required to submit an updated JMF (MAT 440 JMF Change form) for that type of material in order to continue supplying material.

Sampling: AASHTO R-35(M) and M-323

Procedure: Per current specification

As required, an annual submission of all JMF/mix design summary forms conforming to AASHTO R-35(M) and M-323 must be provided for each mix size and level, thirty (30) days minimum prior to production. The HMA supplier shall design and maintain detailed aggregate and mixture test data of each Superpave mix design for three years and provide a copy to the DC upon request. The Form MAT 429 revision 02/25/08 supplied by the DC shall be used for annual JMF submittals. If a different form is used, the form must be approved by the DC prior to use. All other required JMF information as stated in the contract specifications must be submitted along with Form Mat 429.

All consensus component aggregate properties must be provided by an AASHTO Materials Reference Laboratory (AMRL) and certified copies submitted to the DC for review, as part of the mix design/JMF, at least annually. All testing shall be performed in accordance with AASHTO T-304 (M) for Fine Aggregate Angularity (FAA), AASHTO T-176 for Sand Equivalency (S/E), ASTM D-5821 for Coarse Aggregate Angularity (CAA), ASTM D-4791 for Flat/Elongated (F/E), the Gsa, Gsb and Pwa. All JMF submittals shall include current copies of certified consensus property test results from an AMRL

laboratory. The vendor will be notified by e-mail of the status of each JMF/mix design received. When the JMF/mix design is accepted, the vendor will then be notified of that mix's status, PPT, PT, A as described above.

After the acceptance of a JMF/mix design, the Contractor shall notify the DC of any change in source(s) of aggregate, binder, and other JMF changes in writing. All changes shall be reviewed by the DC for approval. Switching or changing component sources from those previously submitted is not allowed unless prior authorization is received. If a vendor wants to make changes in any mix component (aggregate or RAP) by more than 10%, that mix will be placed on a "PPT" status and a new JMF/mix design form MAT 429 shall be submitted and approved prior to production.

The continuous changing of JMFs is strongly discouraged as well as repeated failed trials without a documented effort to correct the problem. Repeated changes in JMFs and failed trials may lead to rejection of the material in question. JMF changes for gradation, Pb, Gmm, and Gse will be approved by the DC subject to the following requirements. JMF changes are permitted on HMA materials provided that:

- they are requested and pre-approved by the DC;
- changes do not exceed 50% of the tolerances for that item;
- they are based on a minimum of a two test trend;
- they are documented with a promptly submitted revised JMF;
- it is understood that the JMF change is effective from the time it was submitted forward and is not retroactive to the previous test or tests;
- request for JMF changes are received by the DC prior to the third test for Marshall materials; and
- request for JMF changes are received by the DC prior to any production for either Marshall or Superpave materials.

JMF changes to the component or mix Gsa, Gsb, Pwa, may be submitted on the JMF MAT 440 form. Aggregate consensus property changes will only be approved with proper documentation that the test results were obtained and performed by an AMRL accredited laboratory and must be submitted with detailed and summary documentation to the DC for approval. Changes to aggregate consensus properties will require a new mix design submittal on Form 429. JMF changes for these items are effective after the DC has reviewed and accepted. There will be no retroactive determinations made.

Reports: JMF annual submittal MAT 429, MAT 440

5.22.3 Vacant

5.23 Vacant

5.24 In-Place Density Testing of HMA

Scope: This procedure covers the determination of the in-place density of HMA by using a calibrated Nuclear Density (ND) Gauge approved by the Engineer. This procedure is used by the Engineer or his representative as an in-situ method to ensure that HMA pavement density requirements are met for acceptance and payment purposes. This procedure establishes the correlation of the gauge, density testing of the material and calculation of the test results for acceptance and payment. Additional field correlation will be performed when placing HMA on limited access highways, as stated in section 5.24.1.

In general, acceptance testing of HMA for density should occur during the time of placement. However, acceptance testing of HMA for density may be performed after placement. Every attempt will be made to perform the acceptance testing within two working days of placement.

Procedure: Field testing of pavement density will be performed as stated herein and ASTM D 2950 (M). The density results obtained by this method will be reported as a percent of the maximum theoretical gravity (Gmm) performed in accordance with AASHTO T 209 (M).

Correlation: All ND gauges will be correlated as directed by the DC each year prior to the start of the construction season or prior to initial use on Department projects. Correlation blocks will be provided by the Department or the gauge manufacturer. Alternate correlation blocks will be approved by the DC. The ND gauge will be correlated in accordance with the manufacturers' recommendations and by determining the count rate and density on approved correlation blocks. The ND gauge correlation procedure is as follows:

A. Each reading will be a minimum of 4 minutes in duration.
B. Four (4) incremental readings will be taken with gauge sitting on correlation block and averaged.
C. Final test results of the ND on the correlation block will be within ± 1.0 pcf of the 164.5 pcf correlation block provided by the Department whether the source is positioned in the thick-lift or thin-lift position.
D. The accuracy correlation (bias) will be determined as the difference from the known block density to the final calculated value as determined above.
E. A bias value will be chosen to adjust the pcf result so the ND gauge meets the accuracy requirements stated in (C). If a ND gauge can not meet the accuracy requirements as stated herein and in ASTM D-2950(M): Appendix A, the ND gauge will be repaired by its owner and/or the manufacturer and correlated prior to its use.
F. This bias will be utilized by the ND gauge owner and recorded on test reports for all occasions when the ND gauge is utilized on HMA materials until a new value is established.
G. The DC reserves the right to require new correlation of a ND when there is evidence to suggest the device is inaccurate.

Standardization: As a minimum, standardization of the ND gauge will be performed daily prior to its use. This process will be performed in accordance with ASTM D-2950(M): Section 8, as described in the manufacturer's guidelines and as directed herein.

A. Each day's standard count reading will be recorded. If the subject value is within 2 standard deviations of the target value established during the time of correlation, the gauge will be accepted for use.
B. If the standard count does not fall within the required 2 standard deviations of the target value established during the time of correlation, additional standard counts may be run. If successive standard counts are not in compliance as stated above, the gauge cannot be used and must be re-correlated.

Test location selection:

After the proper lots and sub-lots for testing are determined, in accordance with Article 4.06.04-1 D-1, the following methods will be used.

A. All distance measurements will be taken by measurement device (measuring wheel) or reference stationing on the project.
B. Longitudinal and transverse test site selection will be established utilizing stratified random sampling, ASTM D 3665.
C. Transverse locations for the test site will be measured from the edge of paver pass.
D. If the random number selected locates a transverse offset less than 1 ft. (0.3m) from either edge, relocate the gauge 1 ft. (0.3m) from that edge.
E. For longitudinal joint testing, determined the test location within each sub-lot by use of random numbers. Longitudinal joint offset calculations are not required.
F. Large vertical masses such as Jersey Barriers can affect the reading of a nuclear gauge. Therefore, when a random number locates the ND gauge less than 1 ft. (0.3m) from any vertical mass, relocate the gauge 1 ft. (0.3m) from that vertical mass.

Testing Non-Bridge and Bridge HMA pavements:

The operation of the ND gauge for testing pavements will be as follows:

A. For all test locations, two 60-second measurements (readings) will be taken in the direction of paving at 180 degree angles to each other (rotated around the center of the gauge). The density value reported for each test location will be the average of the two measurements.

B. For thick-lift HMA overlays of 2 ½ in. or greater in depth, testing will be performed using the testing position recommended by the manufacturer such that approximately 90 percent of a single reading will be affected by the top 3 to 4 in. of material.
C. For thin-lift HMA overlays 1 ½ to 2 ½ in., the testing must be performed using the testing position recommended by the manufacturer such that approximately 90 percent of a single reading will be affected by the top 2 in. of material

Testing HMA Longitudinal Joints of Non-Bridge and Bridge HMA pavements (Hot side only):

D. When successive adjacent (two or more) passes are made by the paver, proper lots and sub-lots for testing must be determined per Article 4.06.04-1 D-1. The following method shall be used while testing the total length of the longitudinal joint(s).
   - The edge of the gauge shall be placed parallel along the "hot side" of longitudinal joint, which locates the gauge source rod approximately 6-in. from the joint.

5.24.1 IN-PLACE Correlation for Density Testing on LIMITED ACCESS HIGHWAYS

1) **Scope:** This procedure covers the determination of the in-place density of HMA by using an approved Nuclear Density (ND) Gauge correlated to HMA cores from the project by the Department on a daily basis. This procedure is used daily as an in-situ method to determine gauge bias and evaluate compliance to density requirements.

2) **Procedure:** Field testing shall be as stated herein. The density results obtained by this in place method shall be reported as a percent of the maximum theoretical gravity (Gmm) performed in accordance with AASHTO T 209 (M). Upon the establishment of this correlation location, the primary or substitute ND gauge shall be verified daily, as specified herein.

a) **Correlation:** The correlation (bias) value for each ND gauge shall be mix, plant and project specific. A bias for a ND gauge can not be carried over from one project to another using the same mix from the same plant. A new correlation may also be required when a different paver is used, the paver screed is repaired or replaced, a mix design change occurs, conditions otherwise change and at the start of the construction season.

The ND gauge correlation procedure is as follows:

i) The location selected for this correlation shall be on the project site on the mainline but in a location that is safely accessible for the duration of the project (such as a shoulder, on-ramp, etc.)
ii) Fourteen (14) gauge readings and five (5) cores will be used to establish the correct bias and correlation. These readings must be taken four (4) feet from an unconfined edge and approximately fifty (50) feet beyond the beginning of the paver pass or as directed by the DC (please refer to diagram A).
iii) The ND gauge must have its bias set to the value established by the DC for the first day of production and payments determined thereof. Each subsequent production day will have payment for density based on the core correlation bias established at the project.
iv) Each ND gauge reading must be a minimum of 60 seconds in duration. Two (2) incremental readings must be taken at 180 degrees to each other for each test location.
v) The fourteen ND gauge readings must be taken parallel to the direction of paving and on the same longitudinal tangent line with the ND locations outlined and marked in paint.
vi) The ND density difference from the high-low of the 7 locations must be $\leq$1.0 percent of the mean of the determined density or a new location will be selected.
vii) The first two locations (1 & 2), location 4, and the last two locations (6 & 7) must be where the cores are taken for correlation purposes. The cores must be taken from within the center of each of the ND gauge footprint at locations 1, 2, 4, 6 and 7 previously marked. Ice should be used to minimize any distortion or damage to cores.
viii) Core thicknesses must match the project plans for the mainline pavement or a new location must be selected.

ix) Location 3 and 5 must remain intact to be used as a daily reference/ correlation for the project ND gauge or substitute ND gauge.

x) The core density difference from the high-low of the five locations must be ≤1.0 percent of the mean of the determined density or a new location must be selected.

xi) The final ND average of percent density from the 7 test locations will be calculated.

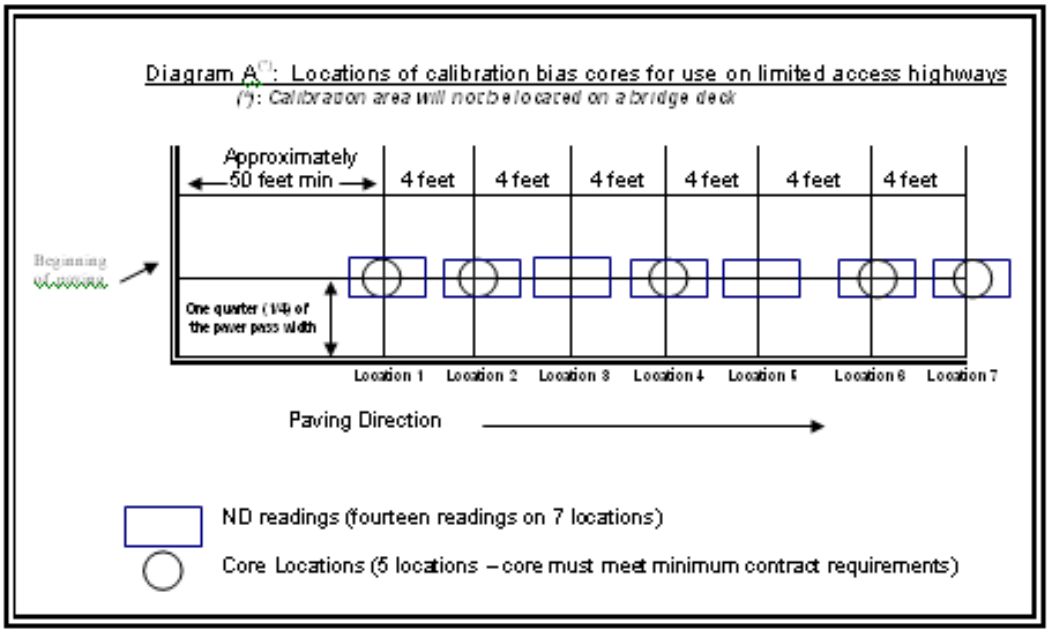
xii) The final core average of percent density from the five cores must be determined and written on the project pavement near locations 3 & 5 to serve as a correlation reference site. The core density average must meet specifications or a new location must be established.

xiii) The ND correlation bias (offset) will be determined as the difference from the known average core density to the known average ND gauge density value, as determined above. This daily bias value must be used with the ND gauge on the project.

xiv) The bias value must be used to check the ND gauge on locations 3 & 5 so that the density of HMA pavement meets an accuracy requirement of ≤ 1.0 percent of known density. One test (2-60 second readings) must be taken each day of production.

xv) If a ND gauge can not meet the accuracy requirements as stated herein, the ND gauge must be repaired by its owner and/or the manufacturer and correlated prior to its use. A substitute gauge will be required to be correlated on locations 3 & 5 and used to establish the bias for that gauge.

xvi) This bias must be utilized by the ND gauge user and recorded on the daily test reports for all occasions when the ND gauge is utilized.



3) **Cores**: All cores must be six inch (6") in diameter or greater. Coring must be performed on the first day of paving. The Contractor shall fill the core holes with approved HMA on the same day. The cores will be tested by the Department. Density results of the core specimens will be determined using AASHTO T 331 (Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method). The density results of the cores will be forwarded to the project and Contractor.

Report: Form CON-133/MAT 438.

5.24.2 Dispute Resolution request by Contractor for HMA density

Dispute Resolution for HMA Density
Scope: The Contractor may request that the dispute resolution process be initiated for HMA Density when it is determined by the DC that in-place material does not meet the minimum density requirements determined by ND gage. The dispute resolution procedure is as follows:
Procedure:

A. The Contractor shall request in writing that it be allowed to obtain cores in the area represented by the non-compliant material to the District administering the contract. If approved, all coring must be directed and witnessed by the DC or his/her representative. The administering unit will be responsible for coordinating the Contractor's activities with Materials Testing personnel.
B. Five cores (6 inch diameter-wet sawed) must be obtained in accordance with ASTM D 3665 by the Contractor at locations on the mat determined by a stratified random procedure performed by the DC to represent the material in question.
C. Five cores (6 inch diameter-wet sawed) must be obtained in accordance with ASTM D 3665 by the Contractor at locations on longitudinal joint (hot side only) by a stratified random procedure performed by the DC to represent the material in question.
D. Cores must be labeled with number, location, and date and stored in a safe manner to ensure no damage occurs to the cores (i.e., core 1M for first mat core; core 1J for first joint core, etc).
E. The cores must be tested in accordance with AASHTO T 331, as modified by the DC. The basis of the adjusted payment will be determined by comparing the average of the 5 core densities to the specifications. The Theoretical Maximum Specific Gravity (Gmm) used to calculate density will be the average Gmm on the day of production in question.
F. All core data will be used for the determination of density except that individual cores that are damaged or obviously defective will be replaced with new cores from the same sub lot.
G. Core holes shall be repaired immediately upon core extraction by decanting any free water, tack coating cut surface, filling with hot mixture of same type, and compacting with hand compactor or other mechanical means to the maximum compaction possible. The final core hole surface shall be with +1/8 inch of the finished pavement prior to opening to traffic.
H. Traffic control, coring equipment, personnel, core hole repairs and HMA materials shall be provided by the Contractor at no expense to the Department.
I. Laboratory testing of all cores will be performed by the DC at no expense to the Contractor.

Report Form: Form CON 133

5.24.3 VACANT

5.25 Density of Soil and Soil - Aggregate by Nuclear Methods

Scope: This procedure covers the determination of the in-place density of soil and soil aggregate by using an approved Nuclear Density (ND) Gauge. The procedure is used as an in-situ method to ensure that the soil density requirements are met for acceptance and payment purposes. These density requirements will be applied to all construction and resurfacing projects where the compacted depth is specified to be a minimum of 1-1/2 in. or greater. This procedure will establish the correlation of the gauge, testing of the material and calculation of the test results.

Procedure: Field testing must be as stated herein and AASHTO T 310 (M). The density results obtained by this method will be reported as a percent of the maximum proctor value performed in accordance with AASHTO T 180 Method D, sampled from the approved source. At the conclusion of each day's production, the final density average will be calculated.
Correlation: All ND gauges must be correlated by the Engineer each year prior to the start of the construction season or prior to initial use on Department projects. Correlation blocks will be provided by the Department or the gauge manufacturer. Alternate correlation blocks must be approved by the DC. The ND gauge must be correlated in accordance with the manufacturers' recommendations and by determining the count rate and density on approved correlation blocks. The range of densities of the correlation blocks must be similar to the expected pavement densities that will be encountered in the field. The ND gauge correlation procedure is as follows:
a. Each reading must be a minimum of 4 minutes in duration.

b. Four (4) incremental readings must be taken with gauge sitting on correlation block and averaged.
c. Final test results of the ND on the correlation block must be within + 1.0 pcf of the 131.5 pcf correlation block provided by the Department whether the source is positioned in the thick-lift or direct transmission position.
d. The accuracy correlation (bias) will be determined as the difference from the known block density to the final calculated value as determined above. A bias value will be chosen to adjust the pcf result so the ND gauge meets the accuracy requirements. If a ND gauge can not meet the accuracy requirements as stated herein, the ND gauge must be repaired by its owner and/or the manufacturer and correlation prior to its use. This bias must be utilized by the ND gauge owner and recorded on test reports for all occasions when the ND gauge is utilized on HMA materials until a new value is established.
e. The Engineer reserves the right to require new correlation of a ND when there is evidence to suggest the source or the device is inaccurate.

Standardization: As a minimum, standardization of the ND gauge must be performed daily prior to its use. This process must be performed as defined in AASHTO T- 310, the manufacturer's guidelines, and as directed herein.
a. Each day's standard count reading must be recorded. If the reading is within 2 standard deviations of the target value established during the time of correlation, the gauge will be acceptable for use.
b. If the standard count does not fall within the required 2 standard deviations of the target value, additional standard counts may be run. If successive standard counts are not in compliance as stated above, the gauge cannot be used and must be re-correlated.

Test location selection: After the proper lots and sub-lots for testing are determined, in accordance with Department Standard Specification Article 4.06.04-1 D-1, the following methods shall be used. All distance measurements shall be taken by measurement device or reference stationing on the project.

a. Field test site selection shall be established utilizing stratified random sampling in accordance with ASTM D 3665, or

b. Select a repetitive feature located within the testing area, such as utility poles or job stationing. Count the number of markers present and divide by the number of tests to be performed, so that the lot is divided equally into a number of sub-lots (for example: if the lot spans 30 utility poles and 10 tests are required, each sub-lot will span 3 utility poles.)

c. For soil testing, determine the longitudinal and transverse test location within each sub-lot by use of random numbers. If the random number selected locates a transverse offset less than 1 ft. (0.3m) from a limit of the material, relocate the gauge 1 ft. (0.3m) from that location

d. Large masses such as traffic barriers can affect the accuracy of the ND gauge. Gauges located closer than 1 ft. (0.3m) from any such mass, should be relocated prior to use.

Testing Soils: The operation of the ND gauge will be as follows: a. for all test locations, four 30-second measurements must be taken at 90 degree angles to each other (rotated around the center of the gauge). The density value reported for each test location must be the average of the two measurements taken in either the BS or Direct Transmission mode.
Report - Form CON-125

5.26 Resistance of Compacted HMA to Moisture – Induced Damage

Scope - This method covers preparation of specimens and measurement of the change of diametral tensile strength resulting from the effects of saturation and accelerated water conditioning of compacted HMA mixtures in the laboratory. This test will be performed on HMA Laboratory mixture, mixtures sampled from newly loaded trucks, field pavement samples, and pavement cores.

Sampling and Procedure - AASHTO T 283(M)

Report - AASHTO T-283(M) Table 1, or form MAT 428