

ITEM 344

PERFORMANCE-DESIGNED MIXTURES

344.1. Description. Construct a pavement layer composed of a compacted performance-designed mixture of aggregate and asphalt binder mixed hot in a mixing plant. Performance-designed mixtures are defined as either Superpave (SP) or coarse-matrix high-binder (CMHB) mixtures.

344.2. Materials. Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources. Notify the Engineer before changing any material source or formulation. When the Contractor makes a source or formulation change, the Engineer will verify that the specification requirements are met and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify specification compliance.

A. Aggregate. Furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for either a coarse aggregate or fine aggregate. When reclaimed asphalt pavement (RAP) is allowed by plan note, provide RAP stockpiles in accordance with this Section. Aggregate from RAP is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. The Engineer will designate the plant or the quarry as the sampling location. Samples must be from materials produced for the project. The Engineer will establish the surface aggregate classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests listed in Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II. Do not add material to an approved stockpile from sources that do not meet the aggregate quality requirements of the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) unless otherwise approved.

1. Coarse Aggregate. Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Provide aggregates from sources listed in the BRSQC. Provide aggregate from nonlisted sources only when tested by the Engineer and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for nonlisted sources.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. The SAC for sources on the Department's Aggregate Quality Monitoring Program (AQMP) is listed in the BRSQC.

Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate in order to meet requirements for Class A materials. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. When blending, do not use Class C or D aggregates. For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.

2. RAP. RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. Crush or break RAP so that 100% of the particles pass the 2-in. sieve.

RAP from either Contractor- or Department-owned sources, including RAP generated during the project, is permitted only when shown on the plans. Department-owned RAP, if allowed for use, will be available at the location shown on the plans. When RAP is used, determine asphalt content and gradation for mixture design purposes. Perform other tests on RAP when shown on the plans.

When RAP is allowed by plan note, use no more than 20% RAP unless otherwise shown on the plans.

Do not use RAP contaminated with dirt or other objectionable materials. Do not use the RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with the laboratory method given in Tex-406-A, Part I. Determine the plasticity index using Tex-106-E if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction.

Do not intermingle Contractor-owned RAP stockpiles with Department-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused Department-owned RAP to the designated stockpile location.

3. **Fine Aggregate.** Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the gradation requirements in Table 2. Supply fine aggregates that are free from organic impurities. The Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. At most 15% of the total aggregate may be field sand or other uncrushed fine aggregate. With the exception of field sand and fine aggregates used in CMHB mixtures, use fine aggregate from coarse aggregate sources that meet the requirements shown in Table 1, unless otherwise approved.

If 10% or more of the stockpile is retained on the No. 4 sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (Tex-460-A) and flat and elongated particles (Tex-280-F).

**Table 1
Aggregate Quality Requirements**

Property	Test Method	Requirement
Coarse Aggregate		
SAC	AQMP	As shown on plans
Deleterious material, %, max	Tex-217-F, Part I	1.0
Decantation, %, max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %, max	Tex-461-A	Note 1
Los Angeles abrasion, %, max	Tex-410-A	35
Magnesium sulfate soundness, 5 cycles, %, max	Tex-411-A	25
Coarse aggregate angularity, 2 crushed faces, %, min	Tex 460-A, Part I	95 ²
Flat and elongated particles @ 5:1, %, max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, max	Tex-107-E	3
Combined Aggregate³		
Sand equivalent, %, min	Tex-203-F	45

1. Not used for acceptance purposes. Used by the Engineer as an indicator of the need for further investigation.

2. Only applies to crushed gravel.

3. Aggregates, without mineral filler, RAP, or additives, combined as used in the job-mix formula (JMF).

**Table 2
Gradation Requirements for Fine Aggregate**

Sieve Size	% Passing by Weight or Volume
3/8"	100
#8	70-100
#200	0-30

- B. **Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, cement, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2% hydrated lime or cement, unless otherwise shown on the plans. The plans may require or disallow specific mineral fillers. When used, provide mineral filler that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter;
- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and

- meets the gradation requirements in Table 3.

Table 3
Gradation Requirements for Mineral Filler

Sieve Size	% Passing by Weight or Volume
#8	100
#200	55-100

- C. Baghouse Fines.** Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.
- D. Asphalt Binder.** Furnish the type and grade of performance-graded (PG) asphalt binder specified on the plans, in accordance with Section 300.2.J, “Performance-Graded Binders.”
- E. Tack Coat.** Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

The Engineer will obtain at least 1 sample of the tack coat binder per project and test it to verify compliance with Item 300. The Engineer will obtain the sample from the asphalt distributor immediately before use.

- F. Additives.** When shown on the plans, use the type and rate of additive specified. Other additives that facilitate mixing or improve the quality of the mixture may be allowed when approved.

If lime or a liquid antistripping agent is used, add in accordance with Item 301, “Asphalt Antistripping Agents.” Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream, unless the plant has a baghouse or dust collection system that reintroduces the lime back into the drum.

344.3. Equipment. Provide required or necessary equipment in accordance with Item 320, “Equipment for Hot-Mix Asphalt Materials.”

344.4. Construction. Produce, haul, place, and compact the specified paving mixture. Schedule and participate in a prepaving meeting with the Engineer as required in the Quality Control Plan (QCP).

- A. Certification.** Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 4. In addition to meeting the certification requirements in Table 4, all Level II certified specialists must successfully complete an approved SP training course. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design that is developed and signed by a Level II certified specialist. Provide a Level IA certified specialist at the plant during production operations. Provide a Level IB certified specialist to conduct placement tests.

**Table 4
Test Methods, Test Responsibility, and Minimum Certification Levels**

1. Aggregate Testing	Test Method	Contractor	Engineer	Level
Sampling	Tex-400-A	✓	✓	IA
Dry sieve	Tex-200-F, Part I	✓	✓	IA
Washed sieve	Tex-200-F, Part II	✓	✓	IA
Deleterious material	Tex-217-F, Part I	✓	✓	II
Decantation	Tex-217-F, Part II	✓	✓	II
Los Angeles abrasion	Tex-410-A		✓	
Magnesium sulfate soundness	Tex-411-A		✓	
Micro-Deval abrasion	Tex-461-A		✓	
Coarse aggregate angularity	Tex-460-A	✓	✓	II
Flat and elongated particles	Tex-280-F	✓	✓	II
Linear shrinkage	Tex-107-E	✓	✓	II
Sand equivalent	Tex-203-F	✓	✓	II
Organic impurities	Tex-408-A	✓	✓	II
2. Mix Design & Verification	Test Method	Contractor	Engineer	Level
Design and JMF changes	Tex-204-F	✓	✓	II
Mixing	Tex-205-F	✓	✓	II
Molding (SGC)	Tex-241-F	✓	✓	IA
Laboratory-molded density	Tex-207-F	✓	✓	IA
VMA	Tex-207-F	✓	✓	II
Rice gravity	Tex-227-F	✓	✓	IA
Ignition oven calibration ¹	Tex-236-F	✓	✓	II
Indirect tensile strength	Tex-226-F	✓	✓	II
Hamburg Wheel test	Tex-242-F	✓	✓	II
Boil test	Tex-530-C	✓	✓	IA

**Table 4 (continued)
Test Methods, Test Responsibility, and Minimum Certification Levels**

3. Production Testing	Test Method	Contractor	Engineer	Level
Random sampling	Tex-225-F		✓	IA
Mixture sampling	Tex-222-F	✓	✓	IA
Molding (SGC)	Tex-241-F	✓	✓	IA
Laboratory-molded density	Tex-207-F	✓	✓	IA
VMA (calculation only)	Tex-207-F	✓	✓	IA
Rice gravity	Tex-227-F	✓	✓	IA
Gradation & asphalt content ¹	Tex-236-F	✓	✓	IA
Control charts	Tex-233-F	✓	✓	IA
Moisture content	Tex-212-F	✓	✓	IA
Hamburg Wheel test	Tex-242-F	✓	✓	II
Micro-Deval abrasion	Tex-461-A		✓	
Boil test	Tex-530-C	✓	✓	IA
Aging ratio	Tex-211-F		✓	
4. Placement Testing	Test Method	Contractor	Engineer	Level
Random sampling	Tex-225-F		✓	IA
Establish rolling pattern	Tex-207-F	✓		IB
In-Place air voids	Tex-207-F	✓	✓	IA
Control charts	Tex-233-F	✓	✓	IA
Ride quality measurement	Tex-1001-S	✓	✓	IB
Segregation (density profile)	Tex-207-F, Part V	✓	✓	IB
Longitudinal Joint Density	Tex-207-F, Part VII	✓	✓	IB
Thermal profile	Tex-244-F	✓	✓	IB
Tack coat adhesion	Tex-243-F		✓	IB

1. Refer to Section 344.4.1.2.c for exceptions to using an ignition oven.

- B. Reporting.** Use Department-provided software to record and calculate all test data. The Engineer and the Contractor shall provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is as given in Table 5 unless otherwise approved. The Engineer and the Contractor shall immediately report to the other party any test result that requires production to be suspended, a payment penalty, or fails to meet the specification requirements. Use the approved communication method (e.g., email, diskette, hard copy) to submit test results to the Engineer.

The Engineer will use the Department-provided software to calculate all pay adjustment factors for the lot. Sublot samples may be discarded after the Engineer and Contractor sign off on the pay adjustment summary documentation for the lot.

Use the procedures described in Tex-233-F to plot the results of all quality control (QC) and quality assurance (QA) testing. Update the control charts as soon as test results for each sublot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

Table 5
Reporting Schedule

Description	Reported by	Reported To	To Be Reported Within
Production Quality Control			
Gradation ¹ Asphalt content ¹ Laboratory-molded density ² Moisture content ³ Boil test ³	Contractor	Engineer	1 working day of completion of the sublot
Production Quality Assurance			
Gradation ³ Asphalt content ³ Laboratory-molded density ¹ Hamburg Wheel test ² Boil test ³ Binder tests ²	Engineer	Contractor	1 working day of completion of the sublot
Placement Quality Control			
In-Place air voids ² Segregation ¹ Longitudinal joint density ¹ Thermal profile ¹	Contractor	Engineer	1 hr. of performing the test for segregation, longitudinal joint density, and thermal profile
Placement Quality Assurance			
In-Place Air Voids ¹ Segregation ² Longitudinal joint density ² Thermal profile ² Aging ratio ²	Engineer	Contractor	1 working day of receipt of the trimmed cores for in-place air voids ⁴
Pay Adjustment Summary	Engineer	Contractor	2 working days of performing all required tests and receiving Contractor test data

1. These tests are required on every sublot.

2. Optional test. To be reported as soon as results become available.

3. To be performed at the frequency shown in Table 12.

4. Additional time is allowed if cores cannot be dried to constant weight within 1 day.

- C. **QCP.** Develop and follow the QCP in detail. Obtain approval from the Engineer for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP to the Engineer before the mandatory prepaving meeting. Receive the Engineer's approval of the QCP before beginning production. Include the following items in the QCP.

1. **Project Personnel.** For project personnel, include:
 - a list of individuals responsible for QC with authority to take corrective action and
 - contact information for each individual listed.
2. **Material Delivery and Storage.** For material delivery and storage, include:
 - the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
 - aggregate stockpiling procedures to avoid contamination and segregation;
 - frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
 - procedure for monitoring the quality and variability of asphalt binder.
3. **Production.** For production, include:
 - loader operation procedures to avoid contamination in cold bins,

- procedures for calibrating and controlling cold feeds,
 - procedures to eliminate debris or oversized material,
 - procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, lime, liquid antistripping),
 - procedures for reporting job control test results, and
 - procedures to avoid segregation and drain-down in the silo.
- 4. Loading and Transporting.** For loading and transporting, include:
- type and application method for release agents and
 - truck loading procedures to avoid segregation.
- 5. Placement and Compaction.** For placement and compaction, include:
- proposed agenda for mandatory prepaving meeting including date and location;
 - type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
 - procedures for the transfer of mixture into the paver while avoiding segregation and preventing material spillage;
 - process to balance production, delivery, paving, and compaction to achieve continuous placement operations;
 - paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
 - procedures to construct quality longitudinal and transverse joints.

D. Mixture Design.

- 1. Design Requirements.** Unless otherwise shown on the plans, use the Superpave design procedure given in Tex-204-F, Part IV, to design a mixture meeting the requirements listed in Tables 1, 2, 3, 6, 7, and 8. Use an approved laboratory to perform the Hamburg Wheel test and provide results with the mixture design or provide the laboratory mixture and request that the Department perform the Hamburg Wheel test. The Construction Division maintains a list of approved laboratories. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the laboratory mixture design.

The Contractor may submit a new mixture design at any time during the project. The Engineer will approve all mixture designs before the Contractor can begin production. When shown on the plans, the Engineer will provide the mixture design.

Design the mixture at the number of gyrations (Ndes) shown on the plans. Unless otherwise shown on the plans, the aggregate gradation may pass above, below, or through the reference zone shown in Table 7. When shown on the plans, design a mixture with a gradation that has stone-on-stone contact and passes below the reference zone shown in Table 7. Verify stone-on-stone contact using the method given in the Superpave design procedure in Tex-204-F, Part IV.

For mixture designated on the plans as a “rich bottom layer” (RBL), design for a target laboratory molded density of 98.0% at Ndes = 50. Design the RBL with a gradation that does not pass below the reference zone shown in Table 7. RBL will only be designated as the bottom lift on perpetual pavement designs.

Provide the Engineer with a mixture design report using Department-provided software. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level II person or persons that performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 6
Master Gradation Bands (% Passing by Weight or Volume)
and Volumetric Properties

Sieve Size	SP-A Base	SP-B Intermediate	SP-C Surface	SP-D Fine Mixture	CMHB-C Coarse Surface	CMHB-F Fine Surface
2"	100.0	–	–	–	–	–
1-1/2"	98.0–100.0	100.0	–	–	–	–
1"	90.0–100.0	98.0–100.0	100.0	–	100.0	–
3/4"	Note 1	90.0–100.0	98.0–100.0	100.0	98.0–100.0	100.0
1/2"	–	Note 1	90.0–100.0	98.0–100.0	72.0–85.0	98.0–100.0
3/8"	–	–	Note 1	90.0–100.0	50.0–70.0	85.0–100.0
#4	–	–	–	Note 1	30.0–45.0	40.0–60.0
#8	19.0–45.0	23.0–49.0	28.0–58.0	32.0–67.0	17.0–27.0	17.0–27.0
#16	1.0–45.0	2.0–49.0	2.0–58.0	2.0–67.0	5.0–27.0	5.0–27.0
#30	1.0–45.0	2.0–49.0	2.0–58.0	2.0–67.0	5.0–27.0	5.0–27.0
#50	1.0–45.0	2.0–49.0	2.0–58.0	2.0–67.0	5.0–27.0	5.027.0
#200	1.0–7.0	2.0–8.0	2.0–10.0	2.0–10.0	5.0–9.0	5.0–9.0
Design VMA², % Minimum						
	13.0	14.0	15.0	16.0	14.0	15.0
Plant-Produced VMA, % Minimum						
	12.5	13.5	14.5	15.5	13.0	14.0
Design VFA³, %						
	65–75	65–75	73–76	73–76	–	–

1. Must retain at least 10% cumulative.
2. Voids in mineral aggregates.
3. Voids filled with asphalt.

Table 7
Reference Zones (% Passing by Weight or Volume)

Sieve Size	SP-A Base	SP-B Intermediate	SP-C Surface	SP-D Fine Mixture	CMHB-C Coarse Surface	CMHB-F Fine Surface
2"	–	–	–	–	N/A	N/A
1-1/2"	–	–	–	–		
1"	–	–	–	–		
3/4"	–	–	–	–		
1/2"	–	–	–	–		
3/8"	–	–	–	–		
#4	39.5–39.5	–	–	–		
#8	26.8–30.8	34.6–34.6	39.1–39.1	47.2–47.2		
#16	18.1–24.1	22.3–28.3	25.6–31.6	31.6–37.6		
#30	13.6–17.5	16.7–20.7	19.1–23.1	23.5–27.5		
#50	11.4–11.4	13.7–13.7	15.5–15.5	18.7–18.7		
#200	–	–	–	–		

Table 8
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Target Laboratory-Molded Density, %	Tex-207-F	96.0
Tensile Strength (dry), psi (molded to 93% ±1% density)	Tex-226-F	85–200 ¹
Dust/Asphalt Ratio ²		0.6–1.6
Boil Test ³	Tex-530-C	–
Hamburg Wheel Test Requirements		
High-Temperature Binder Grade	Test Method	Minimum # of Passes @ 0.5" Rut Depth, Tested @122°F⁴
PG 64 or lower	Tex-242-F	10,000
PG 70		15,000
PG 76 or higher		20,000

1. May exceed 200 psi when approved and may be waived when approved.
2. Defined as % passing #200 sieve divided by asphalt content. Not required for CMHB mixtures.
3. Used to establish baseline for comparison to production results. May be waived when approved.
4. May be decreased or waived when shown on the plans. Test not required for RBL.

2. **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation and target asphalt percentage used to establish target values for hot mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1.

a. **Contractor's Responsibilities.**

- (1) **Providing Superpave Gyrotory Compactor.** Furnish a Superpave gyrotory compactor (SGC), calibrated in accordance with Tex-241-F, for molding production samples. Locate the SGC at the Engineer's field laboratory and make the SGC available to the Engineer for use in molding production samples.
- (2) **Gyrotory Compactor Correlation Factors.** Use Tex-206-F, Part II, to perform a gyrotory compactor correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.
- (3) **Submitting JMF1.** Furnish the Engineer a mix design report (JMF1) and request approval to produce the trial batch. If opting to have the Department perform the Hamburg Wheel test on the laboratory mixture, provide the Engineer with approximately 10,000 g of the design mixture and request that the Department perform the Hamburg Wheel test.
- (4) **Supplying Aggregates.** Provide the Engineer with approximately 40 lb. of each aggregate stockpile unless otherwise directed.
- (5) **Supplying Asphalt.** Provide the Engineer at least 1 gal. of the asphalt material and sufficient quantities of any additives proposed for use.
- (6) **Ignition Oven Correction Factors.** Determine the aggregate and asphalt correction factors from the ignition oven using Tex-236-F. Provide the Engineer with split samples of the mixtures and blank samples used to determine the correction factors.
- (7) **Boil Test.** Perform the test and retain the tested sample from Tex-530-C. Use this sample for comparison purposes during production. The Engineer may waive the requirement for the boil test.
- (8) **Trial Batch Approval.** Upon receiving conditional approval of JMF1 from the Engineer, provide a plant-produced trial batch for verification testing of JMF1 and development of JMF2.
- (9) **Trial Batch Production Equipment.** To produce the trial batch, use only equipment and materials proposed for use on the project.
- (10) **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture is representative of JMF1.
- (11) **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the requirements in Table 9.
- (12) **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into 3 equal portions in accordance with Tex-222-F. Label these portions as "Contractor," "Engineer," and "Referee." Deliver samples to the appropriate laboratory as directed.
- (13) **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the verification testing requirements for gradation, asphalt content, laboratory-molded density, and VMA listed in Table 9 and is in compliance with the Hamburg Wheel test requirement in Table 8. Use an approved laboratory to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

- (14) **Development of JMF2.** After the Engineer grants full approval of JMF1 based on results from the trial batch, evaluate the trial batch test results, determine the optimum mixture proportions, and submit as JMF2.
- (15) **Mixture Production.** After receiving approval for JMF2 and receiving a passing result from the Department’s or a Department-approved laboratory’s Hamburg Wheel test on the trial batch, use JMF2 to produce Lot 1 as described in Section 344.4.I.3.a.(1), “Lot 1 Placement.” As an option, once JMF2 is approved, proceed to Lot 1 production at the Contractor’s risk without receiving the results from the Department’s Hamburg Wheel test on the trial batch.
- If electing to proceed without Hamburg Wheel test results from the trial batch, notify the Engineer. Note that the Engineer may require up to the entire subplot of any mixture failing the Hamburg Wheel test be removed and replaced at the Contractor’s expense.
- (16) **Development of JMF3.** Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.
- (17) **JMF Adjustments.** If necessary, adjust the JMF before beginning a new lot. The adjusted JMF must:
- be provided to the Engineer in writing before the start of a new lot,
 - be numbered in sequence to the previous JMF,
 - meet the master gradation limits shown in Table 6, and
 - be within the operational tolerances of JMF2 listed in Table 9.
- (18) **Requesting Referee Testing.** If needed, use referee testing in accordance with Section 344.4.I.1, “Referee Testing,” to resolve testing differences with the Engineer.

**Table 9
Operational Tolerances**

Description	Test Method	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and Engineer ¹
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.0 ²	±5.0
Individual % retained for sieves smaller than #8 and larger than #200		±3.0 ²	±3.0
% passing the #200 sieve		±2.0 ²	±1.6
Asphalt content, %	Tex-236-F	±0.3 ³	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±0.5
In-Place air voids, %		N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	±0.020
VMA, % min		Note 4	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	± 0.020

1. Contractor may request referee testing only when values exceed these tolerances.
2. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
3. Tolerance between JMF1 and JMF2 may exceed ±0.3%.
4. Test and verify that Table 6 requirements are met.

b. Engineer’s Responsibilities.

- (1) **Gyratory Compactor.** The Engineer will use a Department SGC, calibrated according to Tex-241-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location. The Engineer will make the Contractor-provided SGC in the Department field laboratory available to the Contractor for molding verification samples.
- (2) **Conditional Approval of JMF1.** Within 2 working days of receiving the mixture design report (JMF1) and all required materials and Contractor-provided Hamburg Wheel test results, the Engineer will review the Contractor’s mix design report and verify

conformance with all aggregates, asphalt, additives, and mixture specifications. The Engineer may perform tests to verify the aggregates meet the requirements listed in Table 1. The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test results with laboratory mixture design, a total of 10 working days is allowed for conditional approval of JMF1. Full approval of JMF1 will be based on the Engineer's test results on mixture from the trial batch.

- (3) **Hamburg Wheel Testing of JMF1.** If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the laboratory mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 8.
- (4) **Authorizing Trial Batch.** After conditionally approving JMF1, which will include either Contractor- or Department-supplied Hamburg Wheel test results, the Engineer will authorize the Contractor to produce a trial batch.
- (5) **Ignition Oven Correction Factors.** The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven in accordance with Tex-236-F.
- (6) **Testing the Trial Batch.** Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the gradation, asphalt content, laboratory-molded density, and VMA meet the requirements listed in Table 9. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 8.

The Engineer will have the option to perform the following tests on the trial batch:

- Tex-226-F to verify that the indirect tensile strength meets the requirement shown in Table 7.
 - Tex-461-A to determine the need for additional magnesium sulfate soundness testing.
 - Tex-530-C to retain and use for comparison purposes during production.
- (7) **Full Approval of JMF1.** The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for gradation, asphalt content, laboratory-molded density, and VMA confirm that the trial batch meets the requirements in Table 9.

The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet the requirements in Table 9.

- (8) **Approval of JMF2.** The Engineer will approve JMF2 within 1 working day if it meets the master grading limits shown in Table 6 and is within the operational tolerances of JMF1 listed in Table 9.
- (9) **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with Lot 1 production as soon as a passing result is achieved from the Department's or an approved laboratory's Hamburg Wheel test on the trial batch. As an option, the Contractor may at their own risk, proceed with Lot 1 production without the results from the Hamburg Wheel test on the trial batch.

If the Department's or approved laboratory's sample from the trial batch fails the Hamburg Wheel test, the Engineer will suspend production until further Hamburg Wheel tests meet the specified values. The Engineer may require up to the entire subplot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

- (10) **Approval of JMF3.** The Engineer will approve JMF3 within 1 working day if it meets the master grading limits shown in Table 6 and is within the operational tolerances of JMF2 listed in Table 9.

- E. Production Operations.** Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification.
- 1. Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. On a daily basis, provide the Engineer with the records of asphalt binder and hot mix asphalt discharge temperatures in accordance with Item 320, "Equipment for Hot-Mix Asphalt Materials." Unless otherwise approved, do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr.
 - 2. Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The Department will not pay for or allow placement of any mixture produced at more than 350°F.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. If requested, determine the moisture content by oven-drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.
- F. Hauling Operations.** Before use, clean all truck beds to ensure mixture is not contaminated. When a release agent is necessary, use a release agent on the approved list maintained by the Construction Division to coat the inside bed of the truck.
- G. Placement Operations.** Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 in. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly. Place mixture within the compacted lift thickness shown in Table 10 unless otherwise shown on the plans or allowed.

Table 10
Compacted Lift Thickness and Required Core Height

Mixture Type	Compacted Lift Thickness		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
SP-A	3.00	5.0	2.50
SP-B	2.25	4.0	2.00
SP-C	1.50	3.0	1.25
SP-D	1.25	2.0	1.25
CMHB-C	2.00	4.0	1.75
CMHB-F	1.50	3.0	1.25

- 1. Weather Conditions.** Place mixture when the roadway surface temperature is 60°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.
- 2. Tack Coat.** Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at the rate directed by the Engineer. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a thin, uniform tack coat to all contact surfaces of curbs, structures, and all joints. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Roll the tack coat with a pneumatic-tire roller when directed. The Engineer may use Tex-243-F to verify that the tack coat has adequate adhesive properties. The Engineer may suspend paving operations until there is adequate adhesion.

3. **Lay-Down Operations.** Use the guidelines in Table 11 to establish the temperature of mixture delivered to the paver. Record the information on Department QC/QA forms and submit the forms to the Engineer.
- a. **Thermal Profile.** For each subplot, obtain a thermal profile using Tex-244-F. The Engineer may reduce the testing frequency based on a satisfactory test history. The Engineer may also obtain as many thermal profiles as deemed necessary. If the temperature differential is greater than 25°F, the area will be deemed as having thermal segregation. Evaluate areas with thermal segregation by performing a density profile in accordance with Section 344.4.I.3.c(2), “Segregation (Density Profile).” Take corrective action to eliminate areas that have thermal segregation. Unless otherwise directed, suspend operations if the maximum temperature differential exceeds 50°F. Resume operations when the Engineer determines that subsequent production will meet the specifications.
 - b. **Windrow Operations.** When hot mix is placed in windrows, operate windrow pickup equipment so that substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

Table 11
Suggested Minimum Mixture Placement Temperature

High-Temperature Binder Grade	Minimum Placement Temperature (Before Entering Paver)
PG 64 or lower	260°F
PG 70	270°F
PG 76	280°F
PG 82 or higher	290°F

- H. Compaction.** Uniformly compact the pavement to the density requirements of the specification. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern. Do not use pneumatic-tire rollers if excessive pickup of fines by roller tires occurs. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment.
- Where specific air void requirements are waived, furnish and operate compaction equipment as approved. Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with rollers. The Engineer may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.
- Compact RBL mixtures to achieve a maximum in-place air void value of 4.0%. Core each subplot of the RBL and determine the in-place air voids. Investigate air void deficiencies and take corrective actions during production and placement to achieve required air voids. Suspend production if 2 consecutive sublots fail to meet the air void requirement, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.
- Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. When directed, sprinkle the finished mat with water or limewater to expedite opening the roadway to traffic.
- I. Acceptance Plan.** Sample and test the hot mix on a lot and subplot basis. If the production pay factor for 3 consecutive lots or the placement pay factor for 3 consecutive lots is below 1.000, suspend production until test results or other information indicate, to the satisfaction of the Engineer, that the next material produced or placed will meet the specified values. Pay adjustments for the material will be in accordance with Article 344.6, “Payment.”
- 1. **Referee Testing.** The Construction Division is the referee laboratory. The Contractor may request referee testing if a “remove and replace” condition is determined based on the Engineer’s test results, or if the differences between Contractor and Engineer test results exceed the maximum allowable difference shown in Table 9 and the differences cannot be resolved. Make the request within 5 working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the subplot in question and only for the particular test in question. Allow 10 working days from the time the samples are received at the referee laboratory for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests

if more than 3 referee tests per project are required and the Engineer's test results are closer than the Contractor's test results to the referee test results.

The Construction Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory, and the Engineer's average maximum theoretical specific gravity for the lot. With the exception of remove and replace conditions, referee test results are final and will establish pay adjustment factors for the subplot in question. Sublots subject to be removed and replaced will be further evaluated in accordance with Article 344.6, "Payment."

2. Production Acceptance.

- a. **Production Lot.** A production lot consists of 4 equal sublots. Lot 1 will be 1,000 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production. The lot size will be at least 1,000 tons, but no greater than 4,000 tons. The Engineer may change the lot size before the Contractor begins any lot.

The production pay factor for RBL mixtures is 1.000. Produce and test each production subplot of RBL mix to ensure the laboratory-molded density is between 97.0% to 99.0%. The Engineer may suspend production if laboratory-molded density exceeds the range on 2 consecutive sublots.

- (1) **Small-Quantity Production.** When the anticipated daily production is less than 500 tons or the total production for the project is less than 5,000 tons, the Engineer may waive all quality control and quality assurance (QC/QA) sampling and testing requirements. If the Engineer waives QC/QA sampling and testing, both production and placement pay factors will be 1.000. However, the Engineer will retain the right to perform random acceptance tests for production and placement and may reject objectionable materials and workmanship.

When the Engineer waives all QC/QA sampling and testing requirements:

- produce, haul, place and compact the mixture as directed by the Engineer;
- control mixture production to yield a laboratory-molded density of 96.0% \pm 1.0% as tested by the Engineer; and
- compact the mixture to yield in-place air voids that are greater than or equal to 2.7% and less than or equal to 9.0% as tested by the Engineer.

- (2) **Incomplete Production Lots.** If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Adjust the payment for the incomplete lot in accordance with Section 344.6.A, "Production Pay Adjustment Factors."

b. Production Sampling.

- (1) **Mixture Sampling.** At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with Tex-225-F.

Obtain hot mix samples from trucks at the plant in accordance with Tex-222-F. For each subplot, take 1 sample at the location randomly selected. For each lot, the Engineer will randomly select and test a "blind" sample from at least 1 subplot. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

The sampler will split each sample into 3 equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." Deliver the samples to the appropriate party's laboratory. Deliver referee samples to the Engineer. Discard unused samples after accepting pay adjustment factors for that lot.

- (2) **Asphalt Binder Sampling.** Obtain a 1-qt. sample of the asphalt binder for each subplot of mixture produced. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing

drum or pug mill. Take the sample in accordance with the pipeline sampling procedure given in Tex-500-C, Part II. Label the can with the corresponding lot and subplot numbers, and deliver the sample to the Engineer.

The Engineer may also obtain independent samples. If the Engineer chooses to obtain an independent asphalt binder sample, the Engineer will split a sample of the asphalt binder with the Contractor. The Engineer will test at least 1 asphalt binder sample per project to verify compliance with Item 300, “Asphalts, Oils, and Emulsions.”

- c. **Production Testing.** The Contractor and Engineer must perform production tests in accordance with Table 12. The Contractor has the option to verify the Engineer’s test results on split samples provided by the Engineer. Determine compliance with operational tolerances listed in Table 9 for all sublots.

If the aggregate mineralogy is such that Tex-236-F does not yield reliable results, the Engineer may allow alternate methods for determining the asphalt content and aggregate gradation. Unless otherwise allowed, the Engineer will require the Contractor to provide evidence that results from Tex-236-F are not reliable before permitting an alternate method. If an alternate test method is allowed, use the applicable test procedure as directed.

**Table 12
Production and Placement Testing Frequency**

Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	1 per subplot	1 per 12 sublots
Individual % retained for sieves smaller than #8 and larger than #200			
% passing the #200 sieve			
Laboratory-molded density	Tex-207-F	N/A	1 per subplot
VMA			
Laboratory-molded bulk specific gravity			
In-Place air voids			
Segregation (density profile)	Tex-207-F, Part V	1 per subplot	1 per project
Longitudinal joint density	Tex-207-F, Part VII		
Moisture content	Tex-212-F, Part II	When directed	
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	1 per subplot
Asphalt content	Tex-236-F	1 per subplot	1 per lot
Hamburg Wheel test	Tex-242-F	N/A	1 per project
Thermal profile	Tex-244-F	1 per subplot	
Asphalt binder sampling and testing ¹	Tex-500-C	1 per subplot (sample only)	
Boil test ¹	Tex-530-C	1 per lot	

1. The Engineer may reduce or waive the sampling and testing requirements based on a satisfactory test history.

- d. **Operational Tolerances.** Control the production process within the operational tolerances listed in Table 9. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.
- (1) **Gradation.** Unless otherwise directed, suspend production when either the Contractor’s or the Engineer’s test results for gradation exceed the operational tolerances for 3 consecutive sublots on the same sieve or 4 consecutive sublots on any sieve. The consecutive sublots may be from more than 1 lot.
 - (2) **Asphalt Content.** No production or placement bonus will be paid for any lot that has 2 or more sublots within a lot that are out of operational tolerance for asphalt content based on either the Contractor’s or the Engineer’s test results. Suspend production and shipment of mixture if the asphalt content deviates from the current JMF by more than 0.5% for any subplot.

(3) **Hamburg Wheel Test.** The Engineer may perform a Hamburg Wheel test at any time during production, including when the boil test indicates a change in quality from the materials submitted for JMF1. In addition to testing production samples, the Engineer may obtain cores and perform Hamburg Wheel tests on any area of the roadway where rutting is observed. When the production or core samples fail the Hamburg Wheel test criteria in Table 8, suspend production until further Hamburg Wheel tests meet the specified values. Core samples, if taken, will be obtained from the center of the finished mat or other areas excluding the vehicle wheel path. The Engineer may require up to the entire subplot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

If the Department's or approved laboratory's Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Department confirm the results by retesting the failing material. The Construction Division will perform the Hamburg Wheel tests and determine the final disposition of the material in question based on the Department's test results.

e. **Individual Loads of Hot Mix.** The Engineer can reject individual truckloads of hot mix. When a load of hot mix is rejected for reasons other than temperature, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 9, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load and the Engineer may require removal.

3. Placement Acceptance.

- a. **Placement Lot.** A placement lot consists of 4 placement sublots. A placement subplot consists of the area placed during a production subplot. The placement pay factor for RBL mixtures is 1.000. The Engineer may suspend production of the RBL if the in-place air voids exceed 4.0% on 2 consecutive sublots.
- (1) **Lot 1 Placement.** Placement bonuses for Lot 1 will be in accordance with Section 344.6.B, "Placement Pay Adjustment Factors." However, no placement penalty will be assessed for any subplot placed in Lot 1 when the in-place air voids are greater than or equal to 2.7% and less than or equal to 9.0%. Remove and replace any subplot with in-place air voids less than 2.7% or greater than 9.0%.
 - (2) **Incomplete Placement Lots.** An incomplete placement lot consists of the area placed as described in Section 344.4.I.2.a(2), "Incomplete Production Lot," excluding miscellaneous areas as defined in Section 344.4.I.3.a(4), "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production subplot.
 - (3) **Shoulders and Ramps.** Shoulders and ramps are subject to in-place air void determination and pay adjustments, unless otherwise shown on the plans.
 - (4) **Miscellaneous Areas.** Miscellaneous areas include areas that are not generally subject to primary traffic, such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous areas also include level-ups and thin overlays if the layer thickness designated on the plans is less than the compacted lift thickness shown in Table 10. Miscellaneous areas are not eligible for random placement sampling locations, and will receive a 1.000 placement pay factor. Compact areas that are not subject to in-place air void determination in accordance with Section 344.4.H, "Compaction."
- b. **Placement Sampling.** At the beginning of the project, the Engineer will select random numbers for all placement sublots. The Engineer will provide the Contractor with the placement random numbers immediately after the subplot is completed. Mark the roadway location at the completion of each subplot and record the station number. Determine 1 random sample location for each placement subplot in accordance with Tex-225-F. If the randomly generated sample location is within 2 ft. of a joint or pavement edge, adjust the location by no more than necessary to achieve a 2-ft. clearance.

Shoulders and ramps are always eligible for selection as a random sample location. However, if a random sample location falls on a shoulder or ramp that is designated on the plans as not subject to in-place air void testing, cores will not be taken for the subplot and a 1.000 pay factor will be assigned to that subplot.

Unless otherwise determined, the Engineer will witness the coring operation and measurement of the core thickness. Unless otherwise approved, obtain the cores within 1 working day of the time the placement subplot is completed. Obtain two 6-in.-diameter cores side-by-side from within 1 ft. of the random location provided for the placement subplot. Mark the cores for identification. Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. If an adequate bond does not exist between the current and underlying layer, take corrective action to insure that an adequate bond will be achieved during subsequent placement operations. For SP-C, SP-D, and CMHB-F mixtures, 4-in.-diameter cores are allowed.

Immediately after obtaining the cores, dry the core holes and tack the sides and bottom. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes with other methods when approved.

If the core heights exceed the minimum untrimmed values listed in Table 10, trim and deliver the cores to the Engineer within 1 working day following placement operations unless otherwise approved.

If the core height before trimming is less than the minimum untrimmed value shown in Table 10, decide whether or not to include the pair of cores in the air void determination for that subplot. If the cores are to be included in air void determination, trim the cores before delivering to the Engineer. If the cores will not be included in air void determination, deliver untrimmed cores to the Engineer. The placement pay factor for the subplot will be 1.000 if cores will not be included in air void determination.

- c. **Placement Testing.** Perform placement tests in accordance with Table 12. After the Engineer returns the cores, the Contractor has the option to test the cores to verify the Engineer's test results for in-place air voids. Re-dry the cores to constant weight before testing. The allowable differences between the Contractor's and Engineer's test results are listed in Table 9.

- (1) **In-Place Air Voids.** The Engineer will measure in-place air voids in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be predried using a Corelok or similar vacuum device to remove excess moisture. The Engineer will average the values obtained for all sublots in the production lot to determine the theoretical maximum specific gravity. The Engineer will use the average air void content of the 2 cores to calculate a placement pay adjustment factor.

The Engineer will use paraffin coating or vacuum methods to seal the core if required by Tex-207-F. The Engineer will use the test results from the unsealed core to determine the placement pay adjustment factor if the sealed core yields a higher specific gravity than the unsealed core. After determining the in-place air void content, the Engineer will return the cores and provide test results to the Contractor.

- (2) **Segregation (Density Profile).** Test for segregation using density profiles in accordance with Tex-207-F, Part V. Provide the Engineer with the results of the density profiles as they are completed. Areas defined in Section 344.4.I.3.a(4), "Miscellaneous Areas," are not subject to density profile testing.

Unless otherwise approved, perform a density profile every time the screed stops, on areas that are identified by either the Contractor or the Engineer as having thermal segregation, and on any visibly segregated areas. If the screed does not stop, and there are no visibly segregated areas or areas that are identified as having thermal segregation, perform a minimum of 1 profile per subplot. Reduce the test frequency to a minimum of 1 profile per lot if 4 consecutive profiles are within established tolerances. Continue testing at a minimum frequency of 1 per lot unless a profile fails, at which point resume testing

at a minimum frequency of 1 per subplot. The Engineer may further reduce the testing frequency based on a consistent pattern of satisfactory results.

The density profile is considered failing if it exceeds the tolerances in Table 13. No production or placement bonus will be paid for any subplot that contains a failing density profile. The Engineer may make as many independent density profile verifications as deemed necessary. The Engineer’s density profile results will be used when available.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if 2 consecutive density profiles fail, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

**Table 13
Segregation (Density Profile) Acceptance Criteria**

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
SP-A & SP-B	8.0 pcf	5.0 pcf
SP-C & SP-D CMHB-C & CMHB-F	6.0 pcf	3.0 pcf

(3) Longitudinal Joint Density.

(a) Informational Tests. While establishing the rolling pattern, perform joint density evaluations and verify that the joint density is no more than 3.0 pcf below the density taken at or near the center of the mat. Adjust the rolling pattern if needed to achieve the desired joint density. Perform additional joint density evaluations at least once per subplot unless otherwise directed.

(b) Record Tests. For each subplot, perform a joint density evaluation at each pavement edge that is or will become a longitudinal joint. Determine the joint density in accordance with Tex-207-F, Part VII. Record the joint density information and submit results, on Department forms, to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer may make independent joint density verifications at the random sample locations. The Engineer’s joint density test results will be used when available.

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if 2 consecutive evaluations fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

(4) Recovered Asphalt DSR. The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Construction Division. The aging ratio is the dynamic shear rheometer (DSR) value of the extracted binder divided by the DSR value of the original unaged binder (including RAP binder). DSR values are obtained according to AASHTO T 315 at the specified high temperature performance grade of the asphalt. The binder from RAP will be included proportionally as part of the original unaged binder. The Engineer may require removal and replacement of the defective material at the Contractor’s expense. The asphalt binder will be recovered for testing from production samples or cores using Tex-211-F.

(5) Irregularities. Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected.

The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

At the expense of the Contractor and to the satisfaction of the Engineer, remove and replace any mixture that does not bond to the existing pavement or that has other surface irregularities identified above.

- 4. Ride Quality.** Unless otherwise shown on the plans, measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces."

344.5. Measurement. Hot mix will be measured by the ton of composite hot mix, which includes asphalt, aggregate, and additives. Measure on scales in accordance with Item 520, "Weighing and Measuring Equipment."

344.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under Article 344.5, "Measurement," will be paid for at the unit price bid for "Performance Design Mixtures," of the mixture type, surface aggregate classification, and binder specified. Pay adjustments for bonuses and penalties will be applied as determined in this Item. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Pay adjustment for ride quality will be determined in accordance with Item 585, "Ride Quality for Pavement Surfaces."

- A. Production Pay Adjustment Factors.** The production pay adjustment factor is based on the laboratory-molded density using the Engineer's test results. A pay adjustment factor will be determined from Table 14 for each subplot using the deviation from the target laboratory-molded density defined in Table 8. The production pay adjustment factor for completed lots will be the average of the pay adjustment factors for the 4 sublots sampled within that lot.

**Table 14
Production Pay Adjustment Factors for Laboratory-Molded Density**

Absolute Deviation from Target Laboratory-Molded Density	Production Pay Adjustment Factor
0.0	1.075
0.1	1.075
0.2	1.075
0.3	1.066
0.4	1.057
0.5	1.047
0.6	1.038
0.7	1.029
0.8	1.019
0.9	1.010
1.0	1.000
1.1	0.900
1.2	0.800
1.3	0.700
> 1.3	Remove and replace

- 1. Incomplete Production Lots.** Production pay adjustments for incomplete lots, described under Section 344.4.I.2.a.(2), "Incomplete Production Lots," will be calculated using the average production pay factors from all sublots sampled. A production pay factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples.
- 2. Production Sublots Subject to Removal and Replacement.** If after referee testing, the laboratory-molded density for any subplot results in a "remove and replace" condition as listed in Table 14, the Engineer may require removal and replacement, or may allow the subplot to be left in

place without payment. Replacement material meeting the requirements of this Item will be paid for in accordance with this Article.

- B. Placement Pay Adjustment Factors.** The placement pay adjustment factor is based on in-place air voids using the Engineer’s test results. A pay adjustment factor will be determined from Table 15 for each subplot that requires in-place air void measurement. A placement pay adjustment factor of 1.000 will be assigned to the entire subplot when the random sample location falls in an area on a ramp or shoulder not subject to in-place air void testing. A placement pay adjustment factor of 1.000 will be assigned to quantities placed in miscellaneous areas as described in Section 344.4.I.3.a.(4), “Miscellaneous Areas.” The placement pay adjustment factor for completed lots will be the average of the placement pay adjustment factors for the 4 sublots within that lot.

**Table 15
Placement Pay Adjustment Factors for In-Place Air Voids**

In-Place Air Voids	Pay Adjustment Factor	In-Place Air Voids	Pay Adjustment Factor
< 2.7	Remove and Replace	5.9	1.048
2.7	0.695	6.0	1.045
2.8	0.715	6.1	1.042
2.9	0.735	6.2	1.039
3.0	0.755	6.3	1.036
3.1	0.775	6.4	1.033
3.2	0.795	6.5	1.030
3.3	0.815	6.6	1.027
3.4	0.835	6.7	1.024
3.5	0.855	6.8	1.021
3.6	0.875	6.9	1.018
3.7	0.895	7.0	1.015
3.8	0.915	7.1	1.012
3.9	0.935	7.2	1.009
4.0	0.955	7.3	1.006
4.1	0.975	7.4	1.003
4.2	0.995	7.5	1.000
4.3	1.015	7.6	0.980
4.4	1.035	7.7	0.960
4.5	1.055	7.8	0.940
4.6	1.075	7.9	0.920
4.7	1.075	8.0	0.900
4.8	1.075	8.1	0.880
4.9	1.075	8.2	0.860
5.0	1.075	8.3	0.840
5.1	1.072	8.4	0.820
5.2	1.069	8.5	0.800
5.3	1.066	8.6	0.780
5.4	1.063	8.7	0.760
5.5	1.060	8.8	0.740
5.6	1.057	8.9	0.720
5.7	1.054	9.0	0.700
5.8	1.051	> 9.0	Remove and Replace

A placement pay adjustment factor of 1.000 will be assigned to all sublots for mixtures designated on the plans as “rich bottom layer.” Cores from “rich bottom layer” mixtures are subject to specification requirements described in Section 344.4.H, “Compaction.”

- 1. Incomplete Placement Lots.** Pay adjustments for incomplete placement lots described under Section 344.4.I.3.a.(2), “Incomplete Placement Lots,” will be calculated using the average of the placement pay factors from all sublots sampled and sublots where the random location falls in an area on a ramp or shoulder not eligible for testing. A placement pay adjustment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples.

2. Placement Sublots Subject to Removal and Replacement. If after referee testing the placement pay adjustment factor for any subplot results in a “remove and replace” condition as listed in Table 15, the Engineer will choose the location of 2 cores to be taken within 3 ft. of the original failing core location. The Contractor will obtain the cores in the presence of the Engineer. The Engineer will submit the cores to the Materials and Pavements Section of the Construction Division where they will be tested for bulk specific gravity within 10 working days of receipt. The average bulk specific gravity of the cores will be divided by the Engineer’s average maximum theoretical specific gravity for that lot to determine the new pay adjustment factor of the subplot in question. If the new pay adjustment factor is 0.700 or greater, then the new pay adjustment factor will apply to that subplot. If the new pay adjustment factor is less than 0.700, no payment will be made for the subplot. Remove and replace the failing subplot. Replacement material meeting the requirements of this Item will be paid for in accordance with this Article.

C. Total Adjustment Pay Calculation. Total adjustment pay (TAP) will be based on the applicable pay adjustment factors for production and placement for each lot.

$$TAP = (A + B)/2$$

where:

$A = \text{Bid price} \times \text{production lot quantity} \times \text{average pay adjustment factor for the production lot}$
 $B = \text{Bid price} \times \text{placement lot quantity} \times \text{average pay adjustment factor for the placement lot} +$
(bid price \times miscellaneous quantities \times 1.000)