

SPECIAL SPECIFICATION

3271

Stone-Matrix Asphalt

1. **Description.** Construct a hot-mix asphalt (HMA) pavement layer composed of a compacted stone-matrix asphalt (SMA) or stone-matrix asphalt rubber (SMAR) mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant. Pay adjustments will apply to HMA placed under this specification unless the HMA is deemed exempt in accordance with Section 3271.4.I.4, “Exempt Production.”
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 compliance in accordance with Item 6, “Control of Materials.”

A. Aggregate. Furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse, intermediate, or fine aggregate. Aggregate from reclaimed asphalt pavement (RAP) is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply aggregates that meet the definitions in Tex-100-E for crushed gravel or crushed stone. 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.

1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department’s *Bituminous Rated Source Quality Catalog* (BRSQC) located at <http://www.txdot.gov/business/resources/producer-list.html> are preapproved for use.

For sources not listed on the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance; and
- once approved, do not add material to the stockpile unless otherwise approved.

Use only the rated values for hot mix listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in hot mix. Provide aggregate from non-listed 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 non-listed sources.

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

- a. Blending Class A and Class B Aggregates.** 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; however, Class B virgin (non-recycled) aggregate may be disallowed when shown on the plans. 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. Coarse aggregate from RAP and Recycled Asphalt Shingles (RAS) will be considered as Class B aggregate.

When the Contractor blends Class A and B aggregates to meet a Class A requirement, the Engineer may perform tests at any time during production to ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. In such cases where the Engineer elects to verify conformance, the Engineer will use the Department's mix design Excel template to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks using the gradations supplied by the Contractor on the mixture design report as an input for the Excel template; however, a failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

- b. Micro-Deval Abrasion.** The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate

source used in the mixture design that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 15 as listed in the BRSQC. The Engineer will perform testing prior to the start of production and may perform additional testing at any time during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may elect to waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

When tested, the Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:

Mg_{est} = magnesium sulfate soundness loss

MD_{act} = actual Micro-Deval percent loss

RSMD = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved by the Engineer. The Engineer will consult the Geotechnical, Soils, and Aggregates Branch of the Construction Division, and additional testing may be required prior to granting approval.

- 2. Intermediate Aggregate.** Aggregates not meeting the definition of coarse or fine aggregate will be defined as intermediate aggregate. When used, supply intermediate aggregates that are free from organic impurities. The Engineer may test the intermediate aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. When used, supply intermediate 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).

- 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, 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	30
Magnesium sulfate soundness, 5 cycles, %, max	Tex-411-A	20
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. Used to estimate the magnesium sulfate soundness loss in accordance with Section 3271.2.A.1, "Coarse Aggregate."

2. Only applies to crushed gravel.

3. Aggregates, without mineral filler, RAP, RAS, 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, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2% hydrated lime unless otherwise shown on the plans. Do not use more than 5% fly ash unless otherwise shown on the plans. Test all mineral fillers except hydrated lime and fly ash in accordance with Tex-107-E to ensure specification compliance. 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 binder specified on the plans that meets the requirements of Item 300, “Asphalts, Oils, and Emulsions.”

- 1. Performance-Graded (PG) Binder.** When SMA is specified, provide an asphalt binder with a high-temperature grade of PG 76 and low-temperature grade as shown on the plans in accordance with Section 300.2.J, “Performance-Graded Binders.”
- 2. Asphalt-Rubber (A-R) Binder.** When SMAR is specified, provide A-R binder that meets the Type I or Type II requirements of Section 300.2.I, “Asphalt-Rubber Binders,” unless otherwise shown on the plans. Use at least 15.0% by weight of Crumb Rubber Modifier (CRM) that meets the Grade B or Grade C requirements of Section 300.2.G, “Crumb Rubber Modifier,” unless otherwise shown on the plans. Provide the Engineer the A-R binder blend design with the mix design (JMF1) submittal. Provide the Engineer with documentation such as the bill of lading showing the quantity of CRM used in the project unless otherwise directed.

E. Tack Coat. Furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Specialized or preferred tack coat materials may be allowed by the Engineer or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

The Engineer will obtain at least one sample of the tack coat binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300. The Engineer will obtain the sample from the asphalt distributor immediately before use.

F. Additives. Use the type and rate of additive specified when shown on the plans. Other additives that facilitate mixing, compaction, or improve the quality of the mixture may be allowed when approved. Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.

- 1. Fibers.** When PG binder is specified, provide cellulose or mineral fibers. Submit written certification to the Engineer that the fibers proposed for use meet the requirements of DMS-9204, “Fiber Additives for Bituminous Mixtures.” Fibers may be pre-blended into the binder at the asphalt supply terminal unless otherwise shown on the plans.

When at least 3% RAS is used in the mixture, the Contractor may reduce the amount of fibers as specified in Note 2 of Table 8.

- 2. Lime and Liquid Antistripping Agent.** When 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 into the drum.
- 3. Warm Mix Asphalt (WMA).** Warm Mix Asphalt (WMA) is defined as HMA that is produced within a target temperature discharge range of 215°F and 275°F using Department approved WMA additives or processes. The Department’s Material

Producer List of WMA additives and processes is located at <http://www.txdot.gov/business/resources/producer-list.html>.

WMA is allowed for use on all projects and is required when shown on plans. The maximum placement or target discharge temperature for WMA may be set at a value less than 275°F when shown on the plans.

Department-approved WMA additives or processes may be used to facilitate mixing and compaction of HMA produced at target discharge temperatures greater than 275°F; however, such mixtures will not be defined as WMA.

- G. Recycled Materials.** Use of RAP and RAS is permitted unless otherwise shown on the plans. Do not exceed the maximum allowable percentages of RAP and RAS shown in Table 4. The allowable percentages shown in Table 4 may be decreased or increased when shown on the plans. Determine asphalt content and gradation of the RAP and RAS stockpiles for mixture design purposes in accordance with Tex-236-F. The Engineer may verify the asphalt content of the stockpiles at any time during production. Perform other tests on RAP and RAS when shown on the plans. Asphalt binder from RAP and RAS is designated as recycled asphalt binder. When RAP or RAS is used, calculate and ensure that the ratio of the recycled asphalt binder to total binder does not exceed the percentages shown in Table 4 during mixture design and HMA production. During HMA production, use a separate cold feed bin for each stockpile of RAP and RAS.

Surface and non-surface mixes referenced in Table 4 are defined as follows:

- "Surface" mixes are the final lift or riding surface of the pavement structure; and
 - "Non-Surface" mixes are defined as mixtures that will be an intermediate or base layer in the pavement structure.
- 1. 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.

Use of Contractor-owned RAP including HMA plant waste is permitted unless otherwise shown on the plans. Department-owned RAP stockpiles are available for the Contractor's use when the stockpile locations are shown on the plans. If Department-owned RAP is available for the Contractor's use, the Contractor may use Contractor-owned fractionated RAP and replace it with an equal quantity of Department-owned RAP. Unfractionated RAP is not allowed in SMA and SMAR mixtures. Department-owned RAP generated through required work on the Contract is available for the Contractor's use when shown on the plans. Perform any necessary tests to ensure Contractor- or Department-owned RAP is appropriate for use. The Department will not perform any tests or assume any liability for the quality of the Department-owned RAP unless otherwise shown on the plans. The Contractor will retain ownership of RAP generated on the project when shown on the plans.

Fractionated RAP is defined as having two or more RAP stockpiles, divided into coarse and fine fractions. The coarse RAP stockpile will contain only material

retained by processing over a 3/8 in. screen or 1/2 in. screen unless otherwise approved. The fine RAP stockpile will contain only material passing the 3/8 in. screen or 1/2 in. screen unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 3/8 in. screen or 1/2 in. screen to fractionate the RAP. The maximum percentages of fractionated RAP may be comprised of coarse or fine fractionated RAP or the combination of both coarse and fine fractionated RAP.

Do not use Department- or Contractor-owned RAP contaminated with dirt or other objectionable materials. Do not use Department- or Contractor-owned RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with Tex-406-A, Part I. Determine the plasticity index in accordance with 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 or ignition.

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.

2. **RAS.** Use of post-manufactured RAS or post-consumer RAS (tear-offs) is permitted unless otherwise shown on the plans. RAS is defined as processed asphalt shingle material from manufacturing of asphalt roofing shingles or from re-roofing residential structures. Post-manufactured RAS is processed manufacturer's shingle scrap by-product. Post-consumer RAS is processed shingle scrap removed from residential structures. Comply with all regulatory requirements stipulated for RAS by the Texas Commission on Environmental Quality (TCEQ). RAS may be used separately or in conjunction with RAP.

Process the RAS by ambient grinding or granulating such that 100% of the particles pass the 3/8 in. sieve when tested in accordance with Tex-200-F, Part I. Perform a sieve analysis on processed RAS material prior to extraction (or ignition) of the asphalt.

Add sand meeting the requirements of Table 1 and Table 2 or fine RAP to RAS stockpiles if needed to keep the processed material workable. For any stockpile that contains RAS, the entire stockpile will be considered a RAS stockpile and be limited to no more than 5.0% of the HMA mixture in accordance with Table 4.

Certify compliance of the RAS with DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials (NRM) Guidelines." If the RAS has not come into contact with any hazardous materials, treat it as an established NRM. Use RAS from shingle sources on the Department's Material Producer List of NRM located at <http://www.txdot.gov/business/resources/producer-list.html>. Prior to use, remove substantially all materials that are not part of the shingle, such as wood, paper, metal, plastic, and felt paper. Determine the deleterious content of RAS material for mixture design purposes in accordance with Tex-217-F, Part III. Do not use RAS if deleterious materials are more than 0.5% of the stockpiled RAS unless otherwise

approved. Submit a sample for approval to the Engineer prior to submitting the mixture design. The Department will perform the testing for deleterious material of RAS to determine specification compliance.

Table 4
Maximum Allowable Amounts of Recycled Binder, RAP, and RAS

Mixture Description & Location	Maximum Ratio of Recycled Binder to Total Binder ¹ (%)	Maximum Allowable Recycled Material ² (%)	
		Fractionated RAP ³	RAS ⁴
Surface	15.0	15.0	5.0
Non-Surface	20.0	20.0	5.0

1. Combined recycled binder from fractionated RAP and RAS.
2. Unfractionated RAP is not allowed in SMA or SMAR mixtures
3. May replace up to 5% fractionated RAP with RAS.
4. May be used separately or as a replacement for no more than 5% of the allowable fractionated RAP.

3. **Equipment.** Provide required or necessary equipment in accordance with Item 320, “Equipment for Asphalt Concrete Pavement.” When A-R binder is specified, equip the hot mix plant with an in-line viscosity-measuring device located between the blending unit and the mixing drum. When an asphalt mass flow meter is used, provide a means to calibrate the meter on site.
4. **Construction.** Produce, haul, place, and compact the specified paving mixture. In addition to tests required by the specification, Contractors may perform other QC tests as deemed necessary. At any time during the project, the Engineer may perform production and placement tests as deemed necessary in accordance with Item 5, “Control of the Work.” On or before the first day of paving, it is mandatory to schedule and participate in a pre-paving meeting with the Engineer unless otherwise shown on the plans.
 - A. **Certification.** Personnel certified by the Hot Mix Asphalt Center Certification Program must conduct all mixture designs, sampling, and testing in accordance with Table 5. 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 2 certified specialist. Provide a Level 1A certified specialist at the plant during production operations. Provide a Level 1B certified specialist to conduct placement tests.

**Table 5
Test Methods, Test Responsibility, and Minimum Certification Levels**

Test Description	Test Method	Contractor	Engineer	Level
1. Aggregate and Recycled Material Testing				
Sampling	Tex-400-A	✓	✓	1A
Dry sieve	Tex-200-F, Part I	✓	✓	1A
Washed sieve	Tex-200-F, Part II	✓	✓	1A
Deleterious material	Tex-217-F, Parts I & III	✓	✓	1A
Decantation	Tex-217-F, Part II	✓	✓	1A
Los Angeles abrasion	Tex-410-A		✓	
Magnesium sulfate soundness	Tex-411-A		✓	
Micro-Deval abrasion	Tex-461-A		✓	
Coarse aggregate angularity	Tex-460-A	✓	✓	2
Flat and elongated particles	Tex 280-F	✓	✓	2
Linear shrinkage	Tex-107-E	✓	✓	2
Sand equivalent	Tex-203-F	✓	✓	2
Organic impurities	Tex-408-A	✓	✓	2
2. Asphalt Binder & Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Tack coat sampling	Tex-500-C, Part III	✓	✓	1A/1B
3. Mix Design & Verification				
Design and JMF changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F	✓	✓	1A
VMA ¹ (calculation only)	Tex-204-F	✓	✓	2
Rice gravity	Tex-227-F	✓	✓	1A
Ignition oven correction factors ²	Tex-236-F	✓	✓	2
Drain-down	Tex-235-F	✓	✓	1A
Hamburg Wheel test	Tex-242-F	✓	✓	2
Overlay test	Tex-248-F		✓	
Boil test	Tex-530-C	✓	✓	1A
4. Production Testing				
Selecting random numbers	Tex-225-F, Part I		✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F	✓	✓	1A
VMA ¹ (calculation only)	Tex-204-F	✓	✓	1A
Rice gravity	Tex-227-F	✓	✓	1A
Gradation & asphalt content ²	Tex-236-F	✓	✓	1A
Control charts	Tex-233-F	✓	✓	1A
Moisture content	Tex-212-F	✓	✓	1A
Hamburg Wheel test	Tex-242-F	✓	✓	2
Micro-Deval abrasion	Tex-461-A		✓	
Drain-down	Tex-235-F	✓	✓	1A
Boil test	Tex-530-C	✓	✓	1A
Aging ratio	Tex-211-F		✓	
Overlay test	Tex-248-F		✓	
Cantabro loss	Tex-245-F		✓	
5. Placement Testing				
Selecting random numbers	Tex-225-F, Part II		✓	1A/1B
Trimming roadway cores	Tex-207-F	✓	✓	1A/1B
In-place air voids	Tex-207-F	✓	✓	1A/1B
Establish rolling pattern	Tex-207-F	✓	✓	1B
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note 3
Segregation (density profile)	Tex-207-F, Part V	✓	✓	1B
Longitudinal joint density	Tex-207-F, Part VII	✓	✓	1B
Thermal profile	Tex-244-F	✓	✓	1B

1. Voids in mineral aggregates.

2. Refer to Section 3271.4.I.2.c for exceptions to using an ignition oven.

3. Profiler and operator are required to be certified at the Texas Transportation Institute facility when Surface Test Type B is specified.

B. Reporting and Responsibilities. Use Department-provided Excel templates to record and calculate all test data including but not limited to mixture design, production and placement QC/QA, control charts, thermal profiles, segregation density profiles, and longitudinal joint density. Obtain the latest version of the Excel templates at <http://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html> or from the Engineer. The Engineer and the Contractor will 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 6 unless otherwise approved. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement, a payment penalty, or that fails to meet the specification requirements. Record and submit all test results and pertinent information on Department-provided Excel templates to the Engineer electronically by means of a portable USB flash drive, compact disc, or via email.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Section 5.3, “Conformity with Plans, Specifications, and Special Provisions.”

**Table 6
Reporting Schedule**

Description	Reported By	Reported To	To Be Reported Within
<i>Production Quality Control</i>			
Gradation ¹ Asphalt content ¹ Laboratory-molded density ² Moisture content ³ Boil test ³	Contractor	Engineer	1 working day of completion of the subplot
<i>Production Quality Assurance</i>			
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 subplot
<i>Placement Quality Control</i>			
In-place air voids ² Segregation ¹ Longitudinal joint density ¹ Thermal profile ¹	Contractor	Engineer	1 working day of completion of the lot
<i>Placement Quality Assurance</i>			
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 subplot.
2. Optional test. To be reported as soon as results become available.
3. To be performed at the frequency specified on the plans.
4. 2 days are allowed if cores can not be dried to constant weight within 1 day.

The Engineer will use the Department-provided Excel template 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.

- C. Quality Control Plan (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;
 - contact information for each individual listed; and
 - copies of certification documents for individuals performing specified QC functions.
- 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, RAS, lime, liquid antistriper);
 - 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;
- proposed paving plan (e.g., paving widths and lift thicknesses);
- 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 and good ride quality;
- 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.** Use the SMA or SMAR design procedure given in Tex-204-F, Part VI or Part VII unless otherwise shown in the plans. Design the mixture to meet the requirements listed in Tables 1, 2, 3, 4, 7, 8, and 9.

Design SMA or SMAR mixtures using a Superpave Gyratory Compactor (SGC) at 50 gyrations as the design number of gyrations (N_{design}). The N_{design} level may be reduced to no less than 35 gyrations at the Contractor's discretion.

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 Department maintains the Material Producer List of approved laboratories located at <http://www.txdot.gov/business/resources/producer-list.html>. Provide laboratory mixture and request that the Department perform the Overlay test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel and Overlay test results on the laboratory mixture design.

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design at any time during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

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

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- asphalt content and aggregate gradation of RAP and RAS stockpiles;
- the N_{design} level used
- results of all applicable tests;
- the mixing and molding temperatures;

- the signature of the Level 2 person or persons that performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 7
Master Gradation Limits (% Passing by Weight or Volume)
and VMA Requirements

Sieve Size	SMA-C Coarse	SMA-D Medium	SMA-F Fine	SMAR-C Coarse	SMAR-F Fine
3/4"	100.0 ¹	100.0 ¹	–	100.0 ¹	–
1/2"	80.0–90.0	85.0–99.0	100.0 ¹	72.0–85.0	100.0 ¹
3/8"	25.0–60.0	50.0–75.0	70.0–100.0	50.0–70.0	95.0–100.0
#4	20.0–28.0	20.0–32.0	30.0–60.0	30.0–45.0	40.0–50.0
#8	14.0–20.0	16.0–28.0	20.0–40.0	17.0–27.0	17.0–27.0
#16	8.0–20.0	8.0–28.0	6.0–30.0	12.0–22.0	12.0–22.0
#30	8.0–20.0	8.0–28.0	6.0–30.0	8.0–20.0	8.0–20.0
#50	8.0–20.0	8.0–28.0	6.0–30.0	6.0–15.0	6.0–15.0
#200	8.0–12.0	8.0–12.0	6.0–12.0	5.0–9.0	5.0–9.0
Design VMA, % Minimum					
	17.5	17.5	17.5	19.0	19.0
Production (Plant-Produced) VMA, % Minimum					
	17.0	17.0	17.0	18.5	18.5

1. Defined as maximum sieve size. No tolerance allowed.

Table 8
Laboratory Mixture Design Properties

Mixture Property	SMA Mixtures	SMAR Mixtures	Test Procedure
Design gyrations, (N _{design}) ¹	50	50	Tex-241-F
Target laboratory-molded density, %	96.0	96.0	Tex-207-F
Asphalt binder content, %	6.0-7.0	7.0-10.0	–
Drain-down, %	0.10 max	0.10 max	Tex-235-F
Fiber content, % by wt. of total mixture	0.20 ² -0.50	–	Calculated
CRM content, % by wt. of A-R binder	–	15.0 min	Calculated
Hamburg Wheel test ³ , rut depth @ 20,000 passes tested @ 50°C, mm	12.5 max	12.5 max	Tex-242-F
Overlay test, number of cycles	200 min	200 min	Tex-248-F
Boil test ⁴	–	–	Tex-530-C

1. May be adjusted within a range of 35–100 gyrations when shown on the plans or specification or allowed by the Engineer.

2. When at least 3% RAS is used in the mixture, the Contractor may reduce the amount of fibers to no less than 0.10% provided the mixture meets the drain-down requirement.

3. For SMAR mixes, the number of passes required for the Hamburg Wheel test may be decreased. Other tests may be required for SMAR mixes instead of or in addition to the Hamburg Wheel test when shown on the plans.

4. Used to establish baseline for comparison to production results. May be waived when approved.

2. **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation, N_{design} level, 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. When WMA is used, JMF1 may be designed and submitted to the Engineer without including the WMA additive. When WMA is used, document the additive or process used and recommend rate on the JMF1 submittal. 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. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

Contractor's Responsibilities.

- (1) **Providing Superpave Gyratory Compactor.** Furnish an 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) **Gyratory Compactor Correlation Factors.** Use Tex-206-F, Part II, to perform a gyratory 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) with representative samples of all component materials and request approval to produce the trial batch. Provide the Engineer with approximately 25,000 g of the laboratory mixture and request the Department perform the Overlay test. If opting to have the Department perform the Hamburg Wheel test on the laboratory mixture, provide the Engineer with an additional 10,000 g of the design mixture and request that the Department also 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 in accordance with Tex-236-F. Note that the asphalt content correction factor takes into account the percent fibers in the mixture so that the fibers are excluded from the binder content determination. Prior to the trial batch production, provide the Engineer with split samples of the mixtures, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for quality assurance testing during production. Correction factors established from a previously approved mixture design may be used for the current mixture design, if the mixture design and ignition oven are the same as previously used unless otherwise directed.
- (7) **Boil Test.** Perform the test and retain the tested sample from Tex-530-C until completion of the project or as directed by the Engineer. Use this sample for comparison purposes during production. The Engineer may waive the requirement for the boil test.

- (8) **Trial Batch Production.** Upon receiving conditional approval of JMF1 and authorization from the Engineer to produce a trial batch, provide a plant-produced trial batch, including the WMA additive or process, if applicable, for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements in Table 4 and Table 9. In lieu of a new trial batch, the Engineer may accept test results from recent production of the same mixture.
- (9) **Trial Batch Production Equipment.** To produce the trial batch, use only equipment and materials proposed for use on the project. Provide documentation to verify the calibration or accuracy of the asphalt mass flow meter to measure the binder content, %, of SMAR mixtures. When required, verify that asphalt mass flow meters for A-R binder meet the requirements of 0.4% accuracy in accordance with Item 520, "Weighing and Measuring Equipment." The Engineer may require that the accuracy of the mass flow meter be verified based on quantities used.
- (10) **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.
- (11) **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the specification requirements.
- (12) **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into three 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 mixture requirements in Table 9. The trial batch mixture must also be in compliance with the Hamburg Wheel requirements in Table 8. Use a Department-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. Adjust the asphalt content or gradation to achieve the specified target laboratory-molded density. The asphalt content established for JMF2 is not required to be within any tolerance of the optimum asphalt content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements for production shown in Table 7. If the optimum asphalt content for JMF2 is more than 0.5% lower than the optimum asphalt content for JMF1, the Engineer may perform Tex-248-F on Lot 1 to

confirm the mixture meets the Overlay test requirement of 200 cycles. Verify that JMF2 meets the mixture requirements in Table 4.

- (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 3271.4.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 mixture requirements in Table 4;
 - meet the master gradation limits shown in Table 7; 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 3271.4.I.1, "Referee Testing," to resolve testing differences with the Engineer.

**Table 9
Operational Tolerances**

Description	Test Method	Allowable Difference Between Trial Batch and JMF1 Target	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	Must be Within Master Grading Limits in Table 7	±5.0 ^{2,3}	±5.0
Individual % retained for sieves smaller than #8 and larger than #200			±3.0 ^{2,3}	±3.0
% passing the #200 sieve			±2.0 ^{2,3}	±1.6
Binder content, %	Tex-236-F ⁶	±0.5	±0.3 ³	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0	±0.5
In-place air voids, %		N/A	N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	N/A	±0.020
VMA, % min	Tex-204-F	Note 4	Note 4	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	N/A	± 0.020
Drain-down	Tex-235-F	Note 5	Note 5	Note 5

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. Only applies to mixture produced for Lot 1 and higher.
4. Test and verify that Table 7 requirements are met for VMA.
5. Test and verify that Table 8 requirements are met for drain-down.
6. Determine binder asphalt content from asphalt mass flow meter readouts for SMAR mixtures. When fibers are used, binder content determination excludes the fibers.

b. Engineer’s Responsibilities.

- (1) **Gyratory Compactor.** The Engineer will use a Department SGC, calibrated in accordance with 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 and Authorizing Trial Batch.** Within 2 working days of receiving the mixture design report (JMF1), all required materials, Department-provided Overlay test results, 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, recycled materials, and mixture specifications. 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, 10 working days is allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with Section 3271.2.A.1.b, "Micro-Deval Abrasion." If the Engineer's test results are pending after 2 working days, conditional approval of JMF1 will still be granted within 2 working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

After conditionally approving JMF1, including either Contractor- or Department-supplied Hamburg Wheel test results, the Contractor is authorized to produce a trial batch.

- (3) **Hamburg Wheel and Overlay 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. The Engineer will perform the Overlay test. The Engineer will mold samples in accordance with Tex-248-F to verify compliance with the Overlay test requirements in Table 8.
- (4) **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 used for quality assurance testing during production in accordance with Tex-236-F. The Engineer will verify that the asphalt content correction factor takes into account the percent fibers in the mixture so that the fibers are excluded from the binder content determination.
- (5) **Testing the Trial Batch.** Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements 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-248-F to confirm the mixture meets the Overlay test requirement of 200 cycles; and
 - Tex-530-C, to retain and use for comparison purposes during production.
- (6) **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 the trial batch meet 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 these requirements.

(7) **Approval of JMF2.** The Engineer will approve JMF2 within 1 working day if the mixture meets the requirements in Table 4 and the master grading limits shown in Table 7. The asphalt content established for JMF2 is not required to be within any tolerance of the optimum asphalt content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements shown in Table 7. If the optimum asphalt content for JMF2 is more than 0.5% lower than the optimum asphalt content for JMF1, the Engineer may perform Tex-248-F on Lot 1 to confirm the mixture meets the Overlay test requirement of 200 cycles.

(8) **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with Lot 1 production (using JMF 2) as soon as a passing result is achieved from the Department's or a Department-approved laboratory's Hamburg Wheel test on the trial batch. The Contractor may proceed at its own risk with Lot 1 production without the results from the Hamburg Wheel test on the trial batch.

If the Department's or Department-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 be removed and replaced at the Contractor's expense.

(9) **Approval of JMF3 and Subsequent JMF Changes.** JMF3 and subsequent JMF changes are approved if they meet the mixture requirements in Table 4, the master grading limits shown in Table 7, and are within the operational tolerances of JMF2 shown 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. Submit a new mix design and perform a new trial batch when the asphalt content of:

- either RAP stockpile used in the mix is more than 0.5% higher than the value shown on the mixture design report; or
- RAS stockpile used in the mix is more than 2.0% higher than the value shown on the mixture design report.

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 legible and discernible increments) in accordance with Item 320, "Equipment for Asphalt Concrete Pavement." Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr unless otherwise approved.

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 (or 275°F for WMA) and is not lower than 215°F. The Department will not pay for or allow placement of any mixture produced at more than 350°F.

When WMA is required, produce the WMA within the target temperature discharge range of 215°F and 275°F. Take corrective action any time the discharge temperature of the WMA exceeds the target discharge range. The Engineer may suspend production operations if the Contractor's corrective action is not successful at controlling the production temperature within the target discharge range. Note that when WMA is produced, it may be necessary to adjust burners to ensure complete combustion such that no burner fuel residue remains in the mixture.

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 Department's Material Producer List to coat the inside bed of the truck.

Use only equipment for hauling as defined in Section 3271.4.G.3.c, "Hauling Equipment." Other hauling equipment may be used when allowed by the Engineer.

- G. Placement Operations.** Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour, or as directed by the Engineer. When the Pave-IR system is not used for specification compliance, use a non-contact infrared thermometer to measure and record the internal temperature of the mixture as discharged from the truck or material transfer device prior to or as the mix enters the paver and an approximate station number or GPS coordinates on each ticket. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

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 the mixture at the rate or thickness shown on the plans. The Engineer will use the guidelines in Table 10 to determine the compacted lift thickness of each layer when multiple lifts are required. The thickness determined is based on the rate of 110 lb./sq. yd. for each inch of pavement unless otherwise shown on the plans.

**Table 10
Compacted Lift Thickness and Required Core Height**

Mixture Type	Compacted Lift Thickness Guidelines		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
SMA-C	2.25	4.00	2.00
SMA-D	1.50	3.00	1.25
SMA-F	1.00	2.00	1.25
SMAR-C	2.00	4.00	1.75
SMAR-F	1.50	3.00	1.25

1. Weather Conditions.

- a. When Using a Pave-IR System for Specification Compliance.** The Contractor may pave any time the roadway is dry and the roadway surface temperature is at least 50°F; however, the Engineer may restrict the Contractor from paving surface mixtures if the ambient temperature is likely to drop below 32°F within 12 hours of paving. Operate the Pave-IR system in accordance with Tex-244-F and demonstrate to the Engineer that no recurring severe thermal segregation exists. Provide the Engineer with the automated report described in Tex-244-F on a daily basis unless otherwise directed.
- b. When Not Using a Pave-IR System for Specification Compliance.** Place mixture when the roadway surface temperature is 70°F or higher unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a handheld infrared thermometer. The Engineer may allow mixture placement to begin prior to the roadway surface reaching the required temperature requirements, if conditions are such that the roadway surface will reach the required temperature within 2 hours of beginning placement operations. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer. The Engineer may restrict the Contractor from paving if the ambient temperature is likely to drop below 32°F within 12 hours of paving.

- 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 the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply a thin, uniform tack coat to all contact surfaces of curbs, structures, and all joints. Allow adequate time for emulsion to break completely prior to placing any material. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Roll the tack coat with a pneumatic-tire roller to remove streaks and other irregular patterns when directed.

3. Lay-Down Operations.

- a. Thermal Profile.** Use a thermal camera or an infrared thermometer to obtain thermal profiles on each subplot in accordance with Tex-244-F. When the Pave-IR system is not used for specification compliance, the Engineer will obtain a thermal profile at least once per project. Thermal profiles are not

applicable in areas described in Section 3271.4.I.3.a(4), “Miscellaneous Areas.”

Within 1 working day of the completion of each lot, provide the Engineer with the thermal profile of every subplot within the lot. Report the results of each thermal profile in accordance with Section 3271.4.B, “Reporting and Responsibilities.”

- (1) **Moderate Thermal Segregation.** Any areas that have a temperature differential greater than 25°F but not exceeding 50°F are deemed as having moderate thermal segregation. Take immediate corrective action to eliminate the moderate thermal segregation. Evaluate areas with moderate thermal segregation by performing density profiles in accordance with Section 3271.4.I.3.c(2), “Segregation (Density Profile).”
- (2) **Severe Thermal Segregation.** Any areas that have a temperature differential greater than 50°F are deemed as having severe thermal segregation. When the Pave-IR system is not used for specification compliance, no production or placement bonus will be paid for any subplot that contains severe thermal segregation. Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section. Evaluate areas with severe thermal segregation by performing density profiles in accordance with Section 3271.4.I.3.c(2), “Segregation (Density Profile).” Remove and replace the material in any areas that have both severe thermal segregation and a failing result for Segregation (Density Profile) unless otherwise directed. The subplot in question may receive a production and placement bonus if applicable when the defective material is successfully removed and replaced.
- (3) **Use of the Pave-IR System.** In lieu of obtaining thermal profiles on each subplot using a thermal camera or an infrared thermometer, the Contractor may use the Pave IR system (paver mounted infrared bar) to obtain a continuous thermal profile in accordance with Tex-244-F. When electing to use the Pave-IR system, notify the Engineer prior to beginning placement operations and specify if using the Pave-IR system for specification compliance or for information only. When electing to use the Pave-IR system for information only, use a thermal camera or an infrared thermometer to obtain thermal profiles in accordance with Tex-244-F. When electing to use the Pave-IR system for information only, segregation density profiles are applicable.

When using the Pave-IR system for specification compliance, review the output results on a daily basis. Unless otherwise directed, provide the automated report described in Tex-244-F to the Engineer for review. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the Pave-IR system. The Engineer may suspend paving operations if the Contractor

cannot successfully modify the paving process to eliminate recurring severe thermal segregation. Density profiles are not required and are not applicable when using the Pave-IR system for specification compliance. Upon completion of use of the Pave-IR system for specification compliance or as requested by the Engineer, provide the Engineer with electronic copies of all daily data files that can be used with the Pave-IR system software to generate temperature profile plots.

- 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.
- c. Hauling Equipment.** The Contractor may elect to use belly dumps, live bottom, or end dump trucks to haul and transfer mixture; however, with exception of paving miscellaneous areas, end dump trucks are only allowed when used in conjunction with an MTD with remixing capability or when a Pave-IR system is used for specification compliance unless otherwise allowed by the Engineer.
- d. Screed Heaters.** If the paver stops for more than 5 minutes, turn off screed heaters to prevent overheating of the mat. If the screed heater remains on for more than 5 minutes while the paver is stopped, the Engineer may evaluate the suspect area in accordance with Section 3271.4.I.3.c(4), "Recovered Asphalt Dynamic Shear Rheometer (DSR)."

H. Compaction. Uniformly compact the pavement contain between 3.7% and 7.0% in-place air voids. When the in-place air voids exceed the range of 3.7% and 7.0%, take immediate corrective action to bring the operation within these tolerances. Areas defined in Section 3271.4.I.3.a(4), "Miscellaneous Areas," are not subject to in-place air void determination. In all other areas, the Engineer may obtain and test cores and may suspend operations or require removal and replacement if the in-place air voids are less than 2.7% or greater than 8.0%. The Engineer will allow paving to resume when the proposed corrective action is likely to yield between 3.7% and 7.0% in-place air voids.

Furnish the type, size, and number of rollers required for compaction as approved. Use a pneumatic-tire roller to seal the surface unless excessive pickup of fines occurs. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.

On the first day of production, use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern that will produce the desired in-place air voids unless otherwise directed.

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.

Complete all compaction operations before the pavement temperature drops below 160°F unless otherwise allowed. The Engineer may allow compaction with a light finish roller operated in static mode for pavement temperatures below 160°F.

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. Pay adjustments for the material will be in accordance with Article 3271.6, “Payment.”

Sample and test the hot mix on a lot and subplot basis. If the production pay factor given in Section 3271.6.A, “Production Pay Adjustment Factors,” for two consecutive lots or the placement pay factor given in Section 3271.6.B, “Placement Pay Adjustment Factors,” for two consecutive lots is below 1.000, suspend production until test results or other information indicates to the satisfaction of the Engineer that the next material produced or placed will result in pay factors of at least 1.000.

- 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. The Contractor may also request referee testing if the Engineer’s test results require suspension of production and the Contractor’s test results are within specification limits. 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 tests 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 three 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. The Contractor may decline referee testing and accept the Engineer’s test results when the placement pay adjustment factor for any subplot results in a “remove and replace” condition. Placement sublots subject to be removed and replaced will be further evaluated in accordance with Section 3271.6.B.2, “Placement Sublots Subject to Removal and Replacement.”

2. Production Acceptance.

- a. Production Lot.** A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 tons; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 4,000 tons.

The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three to four sublots are produced each day. The lot size will be between 1,000 tons and 4,000 tons. The Engineer may change the lot size before the Contractor begins any lot.

If the optimum asphalt content for JMF2 is more than 0.5% lower than the optimum asphalt content for JMF1, the Engineer may perform Tex-248-F on Lot 1 to confirm the mixture meets the Overlay test requirement of 200 cycles.

- (1) **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 3271.6.A, "Production Pay Adjustment Factors." Close all lots within 5 working days, unless otherwise allowed by the Engineer.

b. Production Sampling.

- (1) **Mixture Sampling.** Obtain hot mix samples from trucks at the plant in accordance with Tex-222-F. The sampler will split each sample into three equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.
 - (a) **Random Sample.** 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. For each subplot, take one sample at the location randomly selected. The Engineer will perform or witness the sampling of production sublots.
 - (b) **Blind Sample.** For one subplot per lot, the Engineer will obtain and test a "blind" sample in lieu of the random sample collected by the Contractor. The Contractor may test either the "blind" or the random sample; however, referee testing (if applicable) will be based on a comparison of results from the "blind" sample. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer's "blind" sample may be randomly selected in accordance with Tex-225-F for any subplot or selected at the discretion of the Engineer. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.
- (2) **Informational Cantabro Testing.** During the first week of production, randomly select one subplot from Lot 2 or higher for Cantabro testing. Obtain and provide the Engineer with approximately 75 lb. (35 kg) of mixture in sealed containers, boxes, or bags labeled with CSJ, mixture type, lot, and subplot number. The Engineer will ship the mixture to the

Construction Division for testing. Results from this production test will not be used for specification compliance.

- (3) **Asphalt Binder Sampling.** Obtain a 1 qt. (1 gal. for A-R binder) sample of the asphalt binder for each lot 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 in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and subplot numbers and deliver the sample to the Engineer. If obtaining an independent asphalt binder sample, the Engineer will split a sample of the asphalt binder with the Contractor. The Engineer will test at least one 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 11. 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 Engineer's laboratory-molded density on any subplot is less than 95.0% or greater than 97.0%, take immediate corrective action to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

At any time during production the Engineer may require the Contractor to verify the following based on quantities used:

- lime content (within $\pm 0.1\%$ of JMF), when PG binder is specified;
- fiber content (within $\pm 0.03\%$ of JMF), when PG binder is specified; and
- CRM content (within $\pm 1.5\%$ of JMF), when A-R binder is specified

When A-R binder is specified, maintain the in-line measuring device to verify the A-R binder viscosity between 2,500 and 4,000 centipoise at 350°F unless otherwise approved. Record A-R binder viscosity at least once an hour and provide the Engineer with a daily summary unless otherwise directed.

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. Provide evidence that results from Tex-236-F are not reliable before requesting permission to use an alternate method unless otherwise directed. If an alternate test method is allowed, use the applicable test procedure as directed.

**Table 11
Production and Placement Testing Frequency**

Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency ¹
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
Laboratory-molded bulk specific gravity			
In-place air voids			
VMA	Tex-204-F		
Segregation (density profile) ²	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
Drain-down	Tex-235-F	1 per subplot	1 per 12 sublots
Asphalt content	Tex-236-F		1 per lot
Hamburg Wheel test	Tex-242-F	N/A	1 per project
Recycled Asphalt Shingles (RAS) ³	Tex-217-F, Part III	N/A	
Thermal profile ²	Tex-244-F	1 per subplot	
Asphalt binder sampling and testing	Tex-500-C	1 per lot (sample only)	
Tack coat sampling and testing	Tex-500-C, Part III	N/A	
Boil test ⁴	Tex-530-C	1 per lot	
Cantabro Test ⁵	Tex-245-F	1 per project (sample only)	

1. For production defined in Section 3271.I.4, "Exempt Production," the Engineer will test at the frequency listed in the Department's *Guide Schedule of Sampling and Testing* and this specification.

2. Not required when the Pave-IR system is used for specification compliance.

3. Testing performed by the Construction Division or designated laboratory.

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

5. Testing performed by the Construction Division and for informational purposes only.

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. Suspend operation and take corrective action if any aggregate is retained on the maximum sieve size shown in Table 7. A subplot is defined as out of tolerance if either the Engineer's or the Contractor's test results are out of operational tolerance. Unless otherwise directed, suspend production when either the Contractor's or the Engineer's test results for gradation exceed the operational tolerances for three consecutive sublots on the same sieve or four consecutive sublots on any sieve. The consecutive sublots may be from more than one lot.

- (2) **Asphalt Content.** A subplot is defined as out of operational tolerance if either the Engineer's or the Contractor's test results exceed the values listed in Table 9. No production or placement bonus will be paid for any subplot that is out of operational tolerance for asphalt content. Suspend production and shipment of the mixture if the Engineer's or the Contractor's asphalt content deviates from the current JMF by more than 0.5% for any subplot.
- (3) **Voids in Mineral Aggregates (VMA).** The Engineer will determine the VMA for every subplot. For sublots when the Engineer does not determine asphalt content, the Engineer will use the asphalt content results from quality control testing performed by the Contractor to determine VMA.

Take immediate corrective action if the VMA value for any subplot is less than the minimum VMA requirement for production listed in Table 7. Suspend production and shipment of the mixture if the Engineer's VMA results on two consecutive sublots are below the minimum VMA requirement for production listed in Table 7. No production or placement bonus will be paid for any subplot that does not meet the minimum VMA requirement for production listed in Table 7 based on the Engineer's VMA determination.

Suspend production and shipment of the mixture if the Engineer's VMA result is more than 0.5% below the minimum VMA requirement for production listed in Table 7. In addition to suspending production, the Engineer may require removal and replacement or may allow the subplot to be left in place without payment.

- (4) **Fibers.** Suspend production and shipment of the mixture if fiber content varies from the design target value by more than 10% on two consecutive tests.
- (5) **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 Department-approved laboratory's Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request 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, contamination, or excessive uncoated particles, 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 four placement sublots. A placement subplot consists of the area placed during a production subplot.
 - (1) **Lot 1 Placement.** Placement bonuses for Lot 1 will be in accordance with Section 3271.6.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 8.0%. Remove and replace any subplot with in-place air voids less than 2.7% or greater than 8.0%.
 - (2) **Incomplete Placement Lots.** An incomplete placement lot consists of the area placed as described in Section 3271.4.I.2.a.(1), "Incomplete Production Lot," excluding areas defined in Section 3271.4.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, Ramps, Etc.** Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are subject to in-place air void determination and pay adjustments unless designated on the plans as not eligible for in-place air void determination. Intersections may be considered miscellaneous areas when determined by the Engineer.
 - (4) **Miscellaneous Areas.** Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations, such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Temporary detours are subject to in-place air void determination when shown on the plans. Miscellaneous areas also include level-ups and thin overlays when the layer thickness specified on the plans is less than the minimum untrimmed core height eligible for testing shown in Table 10. The specified layer thickness is based on the rate of 110 lb./sq. yd. for each inch of pavement unless another rate is shown on the plans. Miscellaneous areas are not eligible for random placement sampling locations. Compact miscellaneous areas in accordance with Section 3271.4.H, "Compaction." Miscellaneous areas are not subject to

in-place air void determination, thermal profiles testing, segregation (density profiles), or longitudinal joint density evaluations.

- 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 one 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, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are always eligible for selection as a random sample location; however, if a random sample location falls on one of these areas and the area is designated on the plans as not subject to in-place air void determination, cores will not be taken for the subplot and a 1.000 pay factor will be assigned to that subplot.

Provide the equipment and means to obtain and trim roadway cores on site. On site is defined as in close proximity to where the cores are taken. Obtain the cores within 1 working day of the time the placement subplot is completed unless otherwise approved. 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, measure and record the untrimmed core height, and provide the information to the Engineer. The Engineer will witness the coring operation and measurement of the core thickness. 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 ensure that an adequate bond will be achieved during subsequent placement operations.

Immediately after obtaining the cores from the roadway, trim the cores in accordance with Tex-207-F if the core heights meets the minimum untrimmed value listed in Table 10. Trim the cores on site in the presence of the Engineer. Use a permanent marker or paint pen to record the lot and subplot numbers on each core as well as the designation as Core A or B. The Engineer may require additional information to be marked on the core and may choose to sign or initial the core. The Engineer will take custody of the cores immediately after they are trimmed and will retain custody of the cores until the Department's testing is completed. Prior to turning the trimmed cores over to the Engineer, the Contractor may elect to wrap the trimmed cores or secure them in a manner that will reduce the risk of possible damage occurring during transport by the Engineer. After testing, the Engineer will return the cores to the Contractor.

The Engineer may elect to have the cores transported back to the Department's laboratory at the HMA plant via the Contractor's haul truck or other designated vehicle. In such cases where the cores will be out of the Engineer's possession during transport, the Engineer will use the Construction Division's protocol to

provide a secure means and process that protects the integrity of the cores during transport.

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

In lieu of the Contractor trimming the cores on site immediately after coring, the Engineer and the Contractor may mutually agree to have the trimming operations performed at an alternate location such as a field laboratory or other similar location. In such cases, the Engineer will take possession of the cores immediately after they are obtained from the roadway and will retain custody of the cores until testing is completed. Either the Department or Contractor representative may perform trimming of cores. The Engineer will witness all trimming operations in cases where the Contractor representative performs the trimming operation.

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.

- 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. 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 pre-dried 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 for in-place air voids.

The Engineer will use the vacuum method 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. Density profiles are not required

and are not applicable when using the Pave-IR system for specification compliance. Density profiles are not applicable in areas described in Section 3271.4.I.3.a(4), “Miscellaneous Areas.”

Unless otherwise approved, perform a density profile every time the paver stops for more than 60 seconds, on areas that are identified by either the Contractor or the Engineer as having thermal segregation, and on any visibly segregated areas. If the paver does not stop for more than 60 seconds, and there are no visibly segregated areas or areas that are identified as having thermal segregation, perform a minimum of one profile per subplot.

Within 1 working day of the completion of each lot, provide the Engineer with the density profile of every subplot within the lot. Report the results of each density profile in accordance with Section 3271.4.B, “Reporting and Responsibilities.”

The density profile is considered failing if it exceeds the tolerances in Table 12. No production or placement bonus will be paid for any subplot that contains a failing density profile. When the Pave-IR system is not used for specification compliance, the Engineer will measure the density profile at least once per project. The Engineer’s density profile results will be used when available. The Engineer may require the Contractor to remove and replace the area in question if the area fails the density profile and has surface irregularities as defined in Section 3271.4.I.3.c(5), “Irregularities.” The subplot in question may receive a production and placement bonus if applicable when the defective material is successfully removed and replaced.

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

Table 12
Segregation (Density Profile) Acceptance Criteria

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
SMA-C & SMAR-C	8.0 pcf	5.0 pcf
SMA-D, SMA-F & SMAR-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. Joint density evaluations are not applicable in areas described in Section 3271.4.I.3.a(4), “Miscellaneous Areas.” 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 will make an independent joint density verification at least once per project and may make independent joint density verifications at the random sample locations. The Engineer’s joint density test results will be used when available.

Within 1 working day of the completion of each lot, provide the Engineer with the joint density of every subplot within the lot. Report the results of each joint density in accordance with Section 3271.4.B, “Reporting and Responsibilities.”

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

- (4) Recovered Asphalt Dynamic Shear Rheometer (DSR).** When the Pave-IR system is not used for specification compliance, 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 DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high temperature PG of the asphalt. 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.** Identify and correct irregularities including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor’s expense) areas of the pavement that contain irregularities and areas where the mixture does not bond to the existing pavement. If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or

may allow the Contractor to continue operations for no more than 1 day while the Contractor is taking appropriate corrective action.

- 4. Exempt Production.** When the anticipated daily production is less than 1,000 tons, the total production for the project is less than 5,000 tons, or when mutually agreed between the Engineer and the Contractor, the Engineer may deem the mixture as exempt production. Production may also be exempt when shown on the plans.

For exempt production, the Contractor is relieved of all production and placement sampling and testing requirements and the production and placement pay factors are 1.000. All other specification requirements apply and the Engineer will perform acceptance tests for production and placement listed in Table 14 at the frequency listed in the Department's *Guide Schedule of Sampling and Testing*.

For exempt production:

- produce, haul, place, and compact the mixture in compliance with the specification as directed by the Engineer;
- control mixture production to yield a laboratory-molded density that is within $\pm 1.0\%$ of the target laboratory-molded density as tested by the Engineer;
- compact the mixture in accordance with Section 3271.4.H, "Compaction"; and
- when the Contractor elects not use the Pave-IR system for specification compliance, the Engineer may perform segregation (density profiles) and thermal profiles in accordance with the specification.

- 5. Ride Quality.** Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

- 5. Measurement.** Hot mix will be measured by the ton of composite hot mix. The composite hot mix is the asphalt, aggregate, and additives. Measure the weights on scales in accordance with Item 520, "Weighing and Measuring Equipment." Provide the Engineer with a daily summary of the asphalt mass flow meter readings for SMAR mixtures unless otherwise directed.

- 6. Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under Article 3271.5, "Measurement," will be paid for at the unit bid price for "Stone Matrix Asphalt" of the mixture type, surface aggregate classification, and binder specified. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals.

Pay adjustments for bonuses and penalties will be applied as determined in this Item; however, a pay adjustment factor of 1.000 will be assigned for all placement sublots for "level ups" only when "level up" is listed as part of the item bid description code. A pay adjustment factor of 1.000 will be assigned to all production and placement sublots when "exempt" is listed as part of the item bid description code.

Applicable pay adjustment bonuses will only be paid for sublots when the Contractor supplies the Engineer with the required documentation for production and placement QC/QA, thermal profiles, segregation density profiles, and longitudinal joint density in accordance with Section 3271.4.B, "Reporting and Responsibilities." If the Contractor uses

the Pave-IR system for specification compliance, documentation is not required for thermal profiles or segregation density profiles on individual sublots; however, the Pave-IR system automated reports described in Tex-244-F are required.

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 13 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 four sublots sampled within that lot.

**Table 13
Production Pay Adjustment Factors for Laboratory-Molded Density¹**

Absolute Deviation from Target Laboratory-Molded Density	Production Pay Adjustment Factor (Target Laboratory-Molded Density)
0.0	1.100
0.1	1.100
0.2	1.100
0.3	1.086
0.4	1.075
0.5	1.063
0.6	1.050
0.7	1.038
0.8	1.025
0.9	1.013
1.0	1.000
1.1	0.900
1.2	0.800
1.3	0.700
>1.3	Remove and replace

1. If the Engineer’s laboratory-molded density on any subplot is less than 95.0% or greater than 97.0%, take immediate corrective action to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor’s corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

- 1. Payment for Incomplete Production Lots.** Production pay adjustments for incomplete lots, described under Section 3271.4.I.2.a(1), “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 13, the Engineer may require removal and replacement or may allow the subplot to be left in place without payment. The Engineer may also elect to accept the subplot in accordance with Item 5, “Control of

the Work,” Section 5.3.A, “Acceptance of Defective or Unauthorized Work.” Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

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 14 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 designated on the plans as not subject to in-place air void determination. A placement pay adjustment factor of 1.000 will be assigned to quantities placed in areas described in Section 3271.4.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 up to four sublots within that lot.

**Table 14
Placement Pay Adjustment Factors for In-Place Air Voids**

In-Place Air Voids	Placement Pay Adjustment Factor	In-Place Air Voids	Placement Pay Adjustment Factor
< 2.7	Remove and Replace	5.4	1.080
2.7	0.710	5.5	1.075
2.8	0.740	5.6	1.070
2.9	0.770	5.7	1.065
3.0	0.800	5.8	1.060
3.1	0.830	5.9	1.055
3.2	0.860	6.0	1.050
3.3	0.890	6.1	1.045
3.4	0.920	6.2	1.040
3.5	0.950	6.3	1.035
3.6	0.980	6.4	1.030
3.7	1.010	6.5	1.025
3.8	1.040	6.6	1.020
3.9	1.070	6.7	1.015
4.0	1.100	6.8	1.010
4.1	1.100	6.9	1.005
4.2	1.100	7.0	1.000
4.3	1.100	7.1	0.970
4.4	1.100	7.2	0.940
4.5	1.100	7.3	0.910
4.6	1.100	7.4	0.880
4.7	1.100	7.5	0.850
4.8	1.100	7.6	0.820
4.9	1.100	7.7	0.790
5.0	1.100	7.8	0.760
5.1	1.095	7.9	0.730
5.2	1.090	8.0	0.700
5.3	1.085	> 8.0	Remove and Replace

1. Payment for Incomplete Placement Lots. Pay adjustments for incomplete placement lots described under Section 3271.4.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 designated on the plans as not eligible for in-place air void determination. 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 14, the Engineer will choose the location of two 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 take immediate possession of the untrimmed cores and submit the untrimmed cores to the Construction Division, where they will be trimmed if necessary and 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, 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, or the Engineer may allow the subplot to be left in place without payment. The Engineer may also elect to accept the subplot in accordance with Item 5, “Control of the Work,” Section 5.3.A, “Acceptance of Defective or Unauthorized Work.” Replacement material must meet the requirements of this specification with payment made accordingly.

- C. **Total Adjusted Pay Calculation.** Total adjusted pay (TAP) will be based on the applicable pay adjustment factors for production and placement of each lot.

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

where:

$A = \text{Bid price} \times \text{production lot quantity} \times \text{average pay adjustment factor for the production lot}$

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

$\text{Production lot quantity} = \text{Quantity actually placed} - \text{quantity left in place without payment}$

$\text{Placement lot quantity} = \text{Quantity actually placed} - \text{quantity left in place without payment} - \text{quantity placed in miscellaneous areas}$