

SPECIAL SPECIFICATION

3127

Thin Bonded Permeable Friction Course (TBPFC)

1. **Description.** Construct a surface course composed of a warm spray-applied polymer modified emulsion membrane followed immediately with a permeable mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant.
2. **Materials.** Furnish materials of uniform quality throughout that meet the requirements of the plans and specifications.

Notify the Engineer of all materials sources. Notify the Engineer before changing any material source or formulation. When making 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 of the project to verify specification compliance.

A. Aggregate. Furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for coarse aggregate. Do not use fine aggregate or recycled asphalt pavement (RAP) in permeable friction course (PFC) mixtures. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. The Engineer will designate the plant or the quarry as the sampling location. Samples must be from materials produced for the project. The Engineer will establish the surface aggregate classification (SAC) and perform Los Angeles Abrasion, Magnesium Sulfate Soundness, and Micro-Deval tests. Perform all other aggregate quality tests listed in Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on Tex-200-F, Part II.. Do not add material to an approved stockpile from sources that do not meet the aggregate quality requirements of the Department's Bituminous Rated Source Quality Catalog (BRSQC) unless otherwise approved.

1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Provide aggregates from sources listed in the BRSQC. Provide aggregate from 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 a minimum SAC as shown on the plans. SAC requirements only apply to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. The SAC for sources on the Department's Aggregate Quality Monitoring Program (AQMP) are listed in the BRSQC.

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

2. **RAP.** Do not use RAP in PFC mixtures.

Table 1
Coarse Aggregate Quality Requirements

Property	Test Method	Requirement
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 Cycle, % , 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

1. Only applies to crushed gravel.

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

2. Only applies to crushed gravel.

- B. Baghouse Fines.** Fines collected by the baghouse or other dust collecting equipment may be re-introduced into the mixing drum.
- C. Asphalt Binder.** Furnish performance graded (PG) asphalt binder and fibers unless the plans specify asphalt-rubber (A-R) binder. Provide asphalt binder that meets requirements of Item 300, "Asphalts, Oils, and Emulsions."
 1. **PG Binder.** When PG binder 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. **A-R Binder.** When A-R binder 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.

- D. Membrane.** Provide a smooth and homogeneous polymer modified emulsion meeting the requirements of Table 2.

**Table 2
Polymer Modified Emulsion Requirements**

Test on Emulsion	Test Method	Min	Max
Viscosity @ 77°F, SSF	Tex-513-C	20	100
Storage Stability ¹ , %	Tex-521-C		1
Demulsibility (for anionic emulsions), 35 ml of 0.02 N CaCl ₂ , %	Tex-521-C	60	
Demulsibility (for cationic emulsions), 35 ml 0.8% sodium dioctyl sulfosuccinate, %	Tex-521-C	60	
Sieve Test ² , %	Tex-521-C		0.05
Residue from Distillation @400°F, % Oil Portion from Distillation ml of Oil per 100 g Emulsion ³	Tex-521-C	63	
Test on Residue from Distillation	Test Method	Min	Max
Elastic Recovery @ 50°F, 50 mm/min, %	Tex-539-C	60	
Penetration @ 77°F, 100 g, 5 sec, 0.1 mm	Tex-502-C	100	150

1. After standing undisturbed for 24 hours, the surface must be smooth, must not exhibit a white or milky colored substance, and must be a homogeneous color throughout.
2. May be required by the Engineer only when the emulsion cannot be easily applied in the field.
3. The temperature on the lower thermometer shall be brought slowly to 350°F ± 10°F and maintained at this temperature for 20 minutes. The total distillation shall be completed in 60 ± 5 minutes from the first application of heat.

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

1. **Fibers.** When PG binder is specified, provide cellulose or mineral fibers. Do not use fibers when A-R binder is specified. Submit written certification to the Engineer that the fibers proposed for use meet the requirements of DMS-9204, “Fiber Additives for Bituminous Mixtures.”
 2. **Lime Mineral Filler.** When PG binder is specified, add lime as mineral filler at a rate of 1.0% by weight of the total dry aggregate in accordance with Item 301, “Asphalt Antistripping Agents.” Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime back into the drum..
 3. **Antistripping Agents.** If lime or a liquid antistrip agent is used, add in accordance with Item 301, “Asphalt Antistripping Agents.” When the plans require lime to be added as an antistripping agent, lime added as mineral filler will count towards the total quantity of lime specified.
- 3. Equipment.** Provide required or necessary equipment in accordance with Item 320, “Equipment for Hot-Mix Asphalt Materials.” 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.
- A. Placement Equipment.** Provide equipment that does not damage underlying pavement. Comply with laws and regulations concerning overweight vehicles.

Provide a Paver that meets all the requirements listed below.

1. **Paver.** Furnish a paver that will spray the membrane, apply the PFC mixture, and level the surface of the mat in a single pass. Configure the paver so that the PFC mixture is placed no more than 5 seconds after the membrane is applied. Ensure the paver does not support the weight of any portion of hauling equipment other than the connection. Provide loading equipment that does not transmit vibrations or other motions to the paver that adversely affects the finished pavement quality. Equip the paver with an automatic dual longitudinal-grade control system and an automatic transverse-grade control system.
 - a. **Tractor Unit.** Supply a tractor unit that can push or propel vehicles, dumping directly into the finishing machine to obtain the desired lines and grades to eliminate any hand finishing. Equip the unit with a hitch sufficient to maintain contact between the hauling equipment's rear wheels and the finishing machine's pusher rollers while mixture is unloaded.
 - b. **Membrane Storage Tank and Distribution System.** Equip the paver with an insulated storage tank having a minimum capacity of 900 gallons. Provide a metered mechanical pressure sprayer on the paver to apply a uniform membrane at the specified rate. Locate the spray bar on the paver so that the membrane is applied immediately in front of the screed unit. Provide a read out device on the paver to monitor the membrane application rate.

Unless otherwise directed, furnish a volumetric calibration and strap stick for the tank in accordance with Tex-922-K, Part I. Calibrate the tank within the previous 5 yr. of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, Part II.
 - c. **Variable Width Screed.** Provide a heated compacting (vibratory-tamping bar) screed that will produce a finished surface which meets longitudinal and transverse profile, typical section, and placement requirements. Screed extensions must provide the same compacting action and heating as the main unit, unless otherwise approved.
 - d. **Grade Reference.** Provide a grade reference with enough support that the maximum deflection does not exceed 1/16 in. between supports. Ensure that the longitudinal controls can operate from any longitudinal grade reference, including a string line, ski, mobile string line, or matching shoes. Furnish paver skis or mobile string line at least 40 ft. long unless otherwise approved.
2. **Material Transfer Devices.** Provide the specified type of device when shown on the plans. Ensure devices provide a continuous, uniform mixture

flow to the asphalt paver. When used, provide windrow pick-up equipment constructed to pick up substantially all roadway mixture placed in the windrow.

- 4. Construction.** Produce, haul, place, and compact the specified paving mixture. When shown on the plans, notify the Engineer to schedule and participate in a prepaving meeting with the engineer as required in the Quality Control Plan (QCP).
 - A. Certification.** Personnel certified by the Department-approved hot mix certification program must conduct all mixture designs, sampling, and testing in accordance with Table 3. In addition to meeting the certification requirements in Table 3, all Level II certified specialists must successfully complete an approved Superpave (SP) training course. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design that is developed and signed by a Level II certified specialist. Provide a Level IA certified specialist at the plant during production operations. Provide a Level IB certified specialist to conduct placement tests.

**Table 3
Test Methods, Test Responsibility, and Minimum Certification Levels**

1. Aggregate Testing	Test Method	Contractor	Engineer	Level
Sampling	Tex-400-A			IA
Dry Sieve	Tex-200-F, Part I			IA
Washed Sieve	Tex-200-F, Part II			IA
Deleterious Material	Tex-217-F, Part I			II
Decantation	Tex-217-F, Part II			II
Los Angeles Abrasion	Tex-410-A			
Magnesium Sulfate Soundness	Tex-411-A			
Micro-Deval	Tex-461-A			
Coarse Aggregate Angularity	Tex-460-A			II
Flat and Elongated Particles	Tex 280-F			II
2. Mix Design & Verification	Test Method	Contractor	Engineer	Level
Design and JMF Changes	Tex-204-F			II
Mixing	Tex-205-F			II
Molding (SGC)	Tex-241-F			IA
Laboratory-molded Density	Tex-207-F, Part VIII			IA
Rice Gravity	Tex-227-F			IA
Ignition Oven Calibration ¹	Tex-236-F			II
Drain-down	Tex-235-F			IA
Boil Test	Tex-530-C			IA
Cantabro Loss	Tex-245-F			II
3. Production Testing	Test Method	Contractor	Engineer	Level
Control Charts	Tex-233-F			IA
Mixture Sampling	Tex-222-F			IA
Gradation & Asphalt Content ¹	Tex-236-F			IA
Moisture Content	Tex-212-F			IA
Micro-Deval	Tex-461-A			
Drain-down	Tex-235-F			IA
Boil Test	Tex-530-C			IA
Aging Ratio	Tex-211-F			
4. Placement Testing	Test Method	Contractor	Engineer	Level
Control Charts	Tex-233-F			IA
Ride Quality Measurement	Tex-1001-S			IB
Thermal profile	Tex-244-F			IB
Tack Coat Adhesion	Tex-243-F			
Permeability	Tex-246-F			IB

1. Refer to Section 4.E for exceptions to using ignition oven.

B. Reporting. Use Department-provided software to record and calculate all test data. The Engineer and the Contractor will provide any available test results to the other party when requested. The Engineer and the Contractor shall immediately report to the other party any test result that requires production to be suspended or fails to meet the specification requirements. Use the approved communication method (e.g., email, diskette, hard copy) to submit test results to the Engineer.

When directed, use the procedures described in Tex-233-F to plot the results of all productions and placement testing. Update the control charts as soon as test results for each subplot 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.

When directed, 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 quality control QC with authority to take corrective action and
 - contact information for each individual listed.
- 2. Material Delivery and Storage.** For material delivery and storage, include:
 - the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
 - aggregate stockpiling procedures to avoid contamination and segregation;
 - frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
 - procedure for monitoring the quality and variability of asphalt binder and the polymer modified emulsion membrane.
- 3. Production.** For production, include:
 - loader operation procedures to avoid contamination in cold bins,
 - procedures for calibrating and controlling cold feeds,
 - procedures to eliminate debris or oversized material,
 - procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, lime, liquid antistripping),
 - procedures for reporting job control test results, and
 - procedures to avoid segregation and drain-down in the silo.
- 4. Loading and Transporting.** For loading and transporting, include:
 - type and application method for release agents and
 - truck loading procedures to avoid segregation.
- 5. Placement and Compaction.** For placement and compaction, include:
 - proposed agenda for mandatory prepaving meeting including date and location;
 - type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils

- procedures for the transfer of mixture into the paver while avoiding segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations;
- paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

D. Mixture Design. Unless otherwise shown on the plans, use the PFC design procedure given in Tex-204-F, Part V, to design a mixture meeting the requirements listed in Tables 1, 4, 4A, and 5. Use $N_{des} = 50$ as the design number of gyrations..

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

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

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

Table 4
Master Gradation Band (% Passing by Weight or Volume) and Binder Content

Sieve Size	PG 76 Mixtures	A-R Mixtures
3/4"	100.0	100.0
1/2"	80.0-100.0	95.0-100.0
3/8"	35.0-60.0	50.0-80.0
#4	1.0-20.0	0.0-8.0
#8	1.0-10.0	0.0-4.0
#200	1.0-4.0	0.0-4.0
	Binder Content¹, %	
	6.0-7.0	8.0-10.0

1. When PFC mix cannot be designed with a minimum asphalt content of 6.0%, using the available aggregates, follow the guidelines in Table 4A to establish a minimum asphalt content requirement based on the combined aggregate bulk specific gravity.

Table 4A
Guide to Adjust Minimum Asphalt Content Based on Bulk Specific Gravity of Aggregates
Combined Aggregate Bulk Specific Gravity Minimum Asphalt Content %

≤2.75	6.0
2.80	5.9
2.85	5.8
2.90	5.7
2.95	5.6
3.00	5.5

Table 5
Laboratory Mixture Design Properties

Mixture Property	Test Method	Minimum	Maximum
Drain-down, %	Tex-235-F	-	0.20
Laboratory-molded density, %	Tex-207-F, Part VIII	78.0 ¹	82.0
Fiber content ² , %	Calculated	0.20	0.50
Lime content ² , %	Calculated	1.0	2.0
CRM content ³ , %	Calculated	15.0	-
Boil test	Tex-530-C	-	None
Cantabro loss, %	Tex-245-F	-	20.0 ¹

1. Suggested limit. Test and report for informational purposes only.
2. By weight of total mixture. Not required when using A-R.
3. By weight of asphalt. Not required when using PG 76 and fibers.

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

a. Contractor's Responsibilities.

- (1) Providing Superpave Gyrotory Compactor (SGC).** Furnish a SGC calibrated in accordance with Tex-241-F, for molding production samples. Locate the SGC at the field laboratory and make the SGC available to the Engineer for use in molding production samples.
- (2) Gyrotory Compactor Correlation Factors.** Use Tex-206-F, Part II, to perform a gyrotory compactor correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.
- (3) Submitting JMF1.** Furnish the Engineer a mix design report (JMF1) and request approval to produce the trial batch.

- (4) **Supplying Aggregates.** Provide the Engineer with approximately 40 lb. of each aggregate stockpile unless otherwise directed.
- (5) **Supplying Asphalt.** Provide the Engineer at least 1 gal. of the asphalt material and sufficient quantities of any additives proposed for use.
- (6) **Ignition Oven Correction Factors.** Determine the aggregate and asphalt correction factors from the ignition oven using Tex-236-F. Provide the Engineer with split samples of the mixtures and blank samples used to determine the correction factors.
- (7) **Boil Test.** Perform the test and retain the tested sample from Tex-530-C. Use this sample for comparison purposes during production. The Engineer may waive the requirement for the boil test. If signs of stripping exist, add lime or liquid antistripping agents as directed.
- (8) **Trial Batch Approval.** Upon receiving conditional approval of JMF1 from the Engineer, provide a plant-produced trial batch for verification testing of JMF1 and development of JMF2.
- (9) **Trial Batch Production Equipment.** To produce the trial batch, use only equipment and materials proposed for use on the project. Provide documentation to verify the calibration or accuracy of the asphalt flow meter to measure the binder content, %, of A-R Mixtures. When required, verify that asphalt 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 flow meter be verified based on quantities used.
- (10) **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture is representative of JMF1.
- (11) **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the operational tolerances in Table 6.
- (12) **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into 3 equal portions in accordance with Tex-222-F. Label these portions as "Contractor," "Engineer," and "Referee." Deliver samples to the appropriate laboratory.
- (13) **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the verification testing requirements for gradation, binder content, laboratory-molded density, and drain-down listed in Table 6. Provide the Engineer with a copy of the trial batch test results.
- (14) **Development of JMF2.** After the Engineer grants full approval of

JMF1 based on results from the trial batch, evaluate the trial batch test results, determine the optimum mixture proportions, and submit as JMF2.

(15) Mixture Production. After receiving approval for JMF2, use JMF2 to produce Lot 1.

(16) Development of JMF3. Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.

(17) JMF Adjustments. If necessary, adjust the JMF before beginning a new lot. The adjusted JMF must:

- be provided to the Engineer in writing before the start of a new lot,
- be numbered in sequence to the previous JMF,
- meet the master gradation limits shown in Table 4, and
- be within the operational tolerances of JMF2 listed in Table 6.

(18) Requesting Referee Testing. If needed, use the referee testing in accordance with Section 4.I.1, “Referee Testing,” to resolve testing differences with the Engineer.

Table 6
Testing Frequency and Mixture Production Tolerances

b. Engineer’s Responsibilities. Testing Frequency and Mixture Production Tolerances

Test Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency	Operational Tolerance from JMF
Individual % retained for sieve sized larger than #200	Tex-200-F	1 per subplot	1 per 12 sublots	±5.0 ¹
% passing the #200				±2.0 ¹
Laboratory-molded density, %	Tex-207-F, Part VIII	1 per subplot	1 per lot	Table 5
Binder content, %	Tex-236-F ⁴	1 per subplot	1 per lot ²	±0.3
Drain-down, %	Tex-235-F	1 per subplot	1 per 12 sublots	Table 4
Boil test ³	Tex-530-C	1 per project	1 per project	N/A
Asphalt Binder Sampling ³	Tex-500-C	1 per subplot (sample only)	1 per project	N/A
Thermal Profile	Tex-244-F	1 per subplot	1 per project	N/A

1. Aggregate gradation will not exceed limits shown in Table 4.
2. May be obtained from asphalt flow meter readouts.
3. The Engineer may reduce or waive the sampling and testing requirements based on a satisfactory test history.
4. Determine binder content, % from asphalt flow meter readouts for A-R Mixtures.

- (1) **Gyratory Compactor.** For molding trial batch and production samples, the Engineer will use the Contractor-provided SGC at the Contractor's field laboratory or provide and use a Department SGC, calibrated in accordance to Tex-241-F, at an alternate location.
- (2) **Conditional Approval of JMF1.** Within 2 working days of receiving the mixture design report (JMF1) and all required materials, the Engineer will review the Contractor's mixture design report and verify conformance with all aggregates, asphalt, additives, and mixture specifications. The Engineer may perform tests to verify the aggregates meet the requirements listed in Table 1. The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates the Contractor's mixture design meets the specifications. Full approval of JMF1 will be based on the Engineer's test results on mixture from the trial batch.
- (3) **Authorizing Trial Batch.** After conditionally approving JMF1, the Engineer will authorize the Contractor to produce a trial batch.
- (4) **Ignition Oven Correction Factor.** The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven in accordance with Tex-236-F.
- (5) **Testing the Trial Batch.** Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the gradation, binder content, and laboratory-molded density meet the requirements listed in Table 6.

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

- Tex-235-F to verify that drain-down meets the requirement shown in Table 5.
- Tex-461-A to determine the need for additional magnesium sulfate soundness testing.
- Tex-530-C to retain and use for comparison purposes during production.
- Tex-245-F to verify the Cantabro loss meets the requirement shown in Table 5.

- (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 gradation, asphalt content, and laboratory-molded density confirm that the trial batch meets the requirements in Table 6.

The Engineer will notify the contractor that an additional trial batch is required if the trial batch does not meet the requirements in Table 6.

- (7) **Approval JMF2.**The Engineer will approve JMF2 within 1 working day if it meets the master grading limits shown in Table 4 and is within the operational tolerances of JMF1 listed in Table 6.
- (8) **Approval Lot 1 Production.** The Engineer will authorize the Contractor to proceed with Lot 1 production after approving JMF2.
- (9) **Approval of JMF3.**The Engineer will approve JMF3 within 1 working day if it meets the master grading limits shown in Table 4 and is within the operational tolerances of JMF2 listed in Table 6.

2. **JMF Adjustments.** Produce the mixture within the operational tolerances listed in Table 6. The Engineer may suspend production if corrective actions are not taken when operational tolerances are exceeded. With approval from the Engineer, the JMF target values may be adjusted as needed. Document any changes to the JMF with a subsequent JMF number. The Engineer may adjust the target asphalt percentage or fiber percentage within the operational tolerances of the JMF.

- E. Production Operations.** Perform a new trial batch when the plant or plant location is changed. Perform quality control at the frequency and within the tolerances listed in Table 6. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification.

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 of at least 2,500 centipoises at 350 °F unless otherwise approved.

If the aggregate mineralogy is such that Tex-236-F does not yield reliable results, the Engineer may allow alternate methods for determining the asphalt

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

- 1. Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions" or from the manufacturer's recommended values. On a daily basis, provide the Engineer with the records of asphalt binder and hot mix asphalt discharge temperatures in accordance with Section 3.A.1.c. "Heating, Drying, and Mixing Systems". Unless otherwise approved, do not store hot mix for more than 12 hrs. or a time period that affects the quality of the mixture.
- 2. Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The Department will not pay for or allow placement of any mixture produced at more than 350°F.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. If requested, determine the moisture content by oven drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck and perform the test promptly.

- F. Hauling Operations.** Before use, clean all truck beds to ensure mixture is not contaminated. When a release agent is necessary, use a release agent on the approved list maintained by the Construction Division.
- G. Placement Operations.** Prepare the surface by removing raised pavement markers and objectionable material such as moisture and dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Use an approved paver to concurrently apply the membrane and place the PFC mixture to produce a smooth, finished surface with a uniform appearance and texture that meet typical section requirements. Control the speed of the paver to insure that the membrane is exposed for no more than 5 seconds before being covered with PFC. Offset longitudinal joints of successive courses of hot mix 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.
 - 1. Weather Conditions.** Place mixture when the roadway surface temperature is 70°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when general weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

2. **Application of Membrane.** Unless otherwise directed by the Engineer, apply the membrane at the rates shown in Table 7. Spray the membrane using a metered mechanical pressure spray bar at a temperature of 140°F to 180°F. Monitor the membrane application rate and make adjustments to the rate when needed or when directed. If required, verify that the spray bar is capable of applying the membrane at a uniform rate across the entire paving width as directed. Do not let the wheels or other parts of the paving machine contact the freshly applied membrane.

Table 7
Membrane Application Rate, (gallons per square yard)

PFC Lift Thickness	PG 76 Mixture	A-R Mixture
3/4"	0.250	0.225
1"	0.275	0.250
1 1/4"	0.300	0.275
1 1/2"	0.325	0.300

3. **Lay-Down Operations.** Measure the temperature of mixture delivered to the paver and take corrective action if needed to insure the temperature does not drop below 280°F. For each subplot use a handheld infrared thermometer to obtain a thermal profile of the uncompacted mat immediately behind the paver. Record the information on Department QCQA forms and submit the forms to the Engineer.

- a. **Thermal Profile.** For each subplot, obtain a thermal profile using Tex-244-F. The Engineer may also obtain as many thermal profiles as deemed necessary.

No more than a 50°F differential will be allowed along the profile of the uncompacted mat surface immediately behind the paver. Unless otherwise directed, suspend operations and remove and replace material that exceeds the maximum temperature differential of 50°F. Resume operations when the Engineer determines that subsequent production will meet the specifications.

If the temperature differential is greater than 25°F the area will be deemed as having thermal segregation. Take corrective action to eliminate areas that have thermal segregation.

Unless otherwise directed, suspend operations if maximum temperature differential exceeds 50°F. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Item.

- 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.

- H. Compaction.** Roll the freshly placed PFC with a steel-wheeled roller, operated in static mode, to seat the mixture without excessive breakage of the aggregate and to provide a smooth surface and uniform texture. Do not use pneumatic rollers. Thoroughly moisten the roller drums with a soap and water solution to prevent adhesion. Unless otherwise directed, use only water or a Department-approved release agent on rollers, tamps, and other compaction equipment.

The Engineer may use, or require the Contractor to use, Tex-246-F to test and verify that the compacted mixture has adequate permeability. Adjust the mixture design or construction methods if the compacted mixture does not exhibit adequate permeability.

Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. When directed, sprinkle the finished mat with water or limewater to expedite opening the roadway to traffic.

- I. Acceptance Plan.** Sample and test the hot mix on a lot and subplot basis. A production lot consists of 4 equal sublots. Lot 1 will be 1,000 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production. The lot size will be at least 1,000 tons, but no greater than 4,000 tons. The Engineer may change the lot size before the Contractor begins any lot. If the production or placement test results are not within the acceptable tolerances listed in Table 6, suspend production until test results or other information indicate, to the satisfaction of the Engineer, that the next material produced or placed will meet the specified values.

- 1. Referee Testing.** The Construction Division is the referee laboratory. The Contractor may request referee testing if the differences between Contractor and Engineer test results exceed the operational tolerances shown in Table 6 and the differences cannot be resolved. Make the request within 5 working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the subplot in question and only for the particular test in question. Allow 10 working days from the time the samples are received at the referee laboratory for test results to be reported. The Department may require the Contractor to pay for additional referee tests if more than 3 referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.
- 2. Asphalt Binder Sampling.** Obtain a 1-qt. (1 gal. for A-R binder) sample of the asphalt binder for each subplot of mixture produced. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill. Take the sample in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and subplot numbers, and deliver the sample to the Engineer.

The Engineer may also obtain independent samples. If the Engineer chooses to obtain an independent asphalt binder sample, the Engineer will split a

sample of the asphalt binder with the Contractor. The Engineer will test at least 1 asphalt binder sample per project to verify compliance with Item 300. "Asphalts, Oils and Emulsions"

3. **Membrane.** Obtain a 1-qt. sample of the membrane material for each subplot. Obtain the sample from the spray bar on the paver. Label the can with the corresponding lot number, and deliver the sample to the Engineer. The Engineer may also obtain independent samples. If the Engineer chooses to obtain an independent sample, the Engineer will split a sample of the membrane with the Contractor. The Engineer will test at least 1 membrane sample per project to verify specification compliance.
4. **Operational Tolerances.** Control the production process within the operational tolerances listed in Table 6. 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.
5. **Recovered Asphalt DSR.** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Construction Division. The aging ratio is the dynamic shear rheometer (DSR) value of the extracted binder divided by the DSR value of the original unaged binder. DSR values are obtained according to AASHTO T315 at the specified high temperature performance grade 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.
6. **Irregularities.** Immediately take appropriate corrective actions if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected. The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

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

7. **Ride Quality.** Unless otherwise shown on the plans, measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces."
5. **Measurement.** Thin Bonded Permeable Friction Course (TBPFC) will be measured by the ton of composite TBPFC. The composite TBPFC is defined as the membrane,

asphalt, aggregate, and additives. The weights of asphalt and aggregate will be calculated based on the measured weight of PFC and the target percentage of asphalt and aggregate. Measure on scales in accordance with Item 520, "Weighing and Measuring Equipment."

A. Membrane. Unless otherwise noted on the plans, membrane material will be measured by one of the following methods:

- 1. Volume.** Membrane material will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the distributor's calibrated strap stick. The quantity to be measured for payment will be the number of gallons used, as directed, in the accepted membrane.
- 2. Weight.** Membrane material will be measured in tons using certified scales meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved. The transporting truck must have a seal attached to the driving device and other openings. The Engineer may require random checking on public scales, at the Contractor's expense, to verify weight accuracy.

Upon work completion or temporary suspension, any remaining membrane material will be weighed by a certified public weigher, or measured by volume in a calibrated distributor or tank and the quantity converted to tons at the measured temperature. The quantity to be measured will be the number of tons received, minus the number of tons remaining after all directed work is complete, and minus the amount used for other item.

B. Asphalt. The asphalt weight in tons will be determined from the total weight of PFC. Measured asphalt percentage will be obtained using Tex-236-F or asphalt flow meter readings for PG 76 Mixtures, as determined by the Engineer. Measured asphalt percentage will be obtained using asphalt flow meter readings for A-R Mixtures..

- 1. Target Percentage.** The JMF target asphalt percentage will be used to calculate the weight of asphalt binder unless the measured asphalt binder percentage is more than 0.3 percentage points below the JMF target asphalt percentage. Volumetric meter readings will be adjusted to 140°F and converted to weight.
- 2. Measured Percentage.** The measured asphalt percentage will be used for payment for that lot's production when the measured percentage is more than 0.3 percentage points below the JMF target asphalt percentage.

C. Aggregate. The aggregate weight in tons will be determined from the total weight of PFC less the weight of the asphalt.

6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement," will be paid for at the unit price bid

for “TBPFC (Membrane),” for “TBPFC (Asphalt),” and for “TBPFC (Aggregate)” of the types specified. These prices are full compensation for all materials, equipment, labor, tools, and incidentals.

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

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