SPECIAL SPECIFICATION

3142

Ultra-Thin Bonded Hot Mix Wearing Course (UTBHMWC)

1. Description. Construct a surface course composed of a warm spray-applied polymer modified emulsion membrane followed immediately with a hot plant mixed gap-graded paving mixture. Provide a wearing course with a minimum of 1/2 in. for Type A, 5/8 in. for Type B, and 3/4 in. for Type C.

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 throughout the duration 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. Do not use recycled asphalt pavement (RAP) or reclaimed asphalt shingles in ultra-thin bonded hot mix wearing course (UTBHMWC) 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 and perform Tex-107-E on mineral fillers if used. 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 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 Class A requirement. 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.

Unless otherwise shown on the plans, 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 UTBHMWC mixtures.

3. **Fine Aggregate.** Fine aggregates consist of manufactured sands and screenings. 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. Do not use field sand or other uncrushed fine aggregate. Use fine aggregate from coarse aggregate sources that meet the requirements shown in Table 1, unless otherwise approved.

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate Properties		
SAC	AQMP	Class A
Deleterious Material, %, Max	Tex-217-F, Part I	1.0
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval Abrasion, %, Max	Tex-461-A	Note 1
Los Angeles Abrasion, %, Max	Tex-410-A	35
Magnesium Sulfate Soundness, 5-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
Fine Aggregate Properties		
Sand Equivalent, Min	Tex 203F	45
Methylene Blue, Max	AASHTO TP57-99	10

1. Not used for acceptance purpose. Used by the engineer as an indicator of the need for further investigation
2. Only applies to crushed gravel.

Table 2
Gradation Requirements for Fine Aggregate

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

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

- is sufficiently dry, free-flowing, and free from clumps and foreign matter;

- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements in Table 3.

Table 3
Gradation Requirements for Mineral Filler

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

C. Baghouse Fines. Fines collected by the baghouse or other dust collecting equipment may be re-introduced into the mixing drum provided the final combined gradation meets the requirements in Table 6.

D. Asphalt Binder. Furnish performance grade (PG) asphalt binder for the paving mixture that meets requirements of Item 300.

1. PG Binder. Provide an asphalt binder with a high temperature grade of PG76 and a low temperature grade as shown on the plans, in accordance with Section 300.2.J.

2. Membrane. Provide a smooth and homogeneous polymer modified emulsion meeting the requirements of Table 4.

Table 4
Polymer Modified Emulsion Requirements

Test on Emulsion	Test Method	Min	Max
Viscosity @ 77ºF, SSF	T 72	20	100
Storage Stability[1], %	T 59		1
Demulsibility (for anionic emulsions), 35 ml of 0.02 N CaCl2, %	T 59	55	
Demulsibility (for cationic emulsions), 35 ml 0.8% sodium dioctyl sulfosuccinate, %	T 59	55	
Sieve Test[2], %	T 59		0.05
Distillation Test:[3] Residue by distillation, % by wt. Oil portion of distillate, % by vol.	T 59	 63	 0.5
Test on Residue from Distillation	**Test Method**	**Min**	**Max**
Elastic Recovery @ 50ºF, 50 mm/min, %	Tex-539-C	60	
Penetration @ 77ºF, 100 g, 5 sec, 0.1 mm	T 49	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 should be brought slowly to 350°F ± 10°F and maintained at this temperature for 20 minutes. The total distillation should be complete 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.

If lime or a liquid anti-stripping agent is used, add in accordance with Item 301. 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. Equipment. Provide required or necessary equipment in accordance with Item 320.

A. Spray Paver. In addition to the requirements of Item 320, furnish a paver that will spray the membrane, apply the mixture, and level the surface of the mat in a single pass. Configure the paver so that the 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 affect the finished pavement quality. Equip the paver with an automatic dual longitudinal-grade control system and an automatic transverse-grade control system.

1. **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.

2. **Screed.** In addition to meeting Item 320, provide a variable width vibratory screed.

B. Material Transfer Devices. In addition to the requirements of Item 320, ensure that no material is deposited on the roadway in front of the paver. Do not use windrow pick-up devices.

C. Rollers. Provide steel-wheel rollers meeting the requirements of Item 210, except provide rollers weighing a minimum of 10 tons for each roller required. Operate rollers in static (non-vibrating) mode unless otherwise allowed by the Engineer.

4. Construction. Produce, haul, place, and compact the specified paving mixture. Schedule and participate in a pre-paving meeting, as required in the Quality Control Plan (QCP).

A. Certification. Personnel certified by the Department-approved program must conduct all mixture designs, sampling, and testing in accordance with Table 5. In addition to meeting the certification requirements in Table 5, 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 5
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
Sand Equivalency	Tex-203-F	✓	✓	II

1. Aggregate Testing	Test Method	Contractor	Engineer	Level
Methylene Blue	AASHTO TP57-99	✓	✓	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	✓	✓	II
Laboratory-molded Density	Tex-207-F	✓	✓	II
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	✓	✓	
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-222	✓	✓	IA
Ride Quality Measurement	Tex-1001-S	✓	✓	IB
Thermal profile	Tex-244-F	✓	✓	IB
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 will 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 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.

When directed, submit a written QCP to the Engineer before the mandatory pre-paving meeting. Receive the Engineer's approval of the QCP before beginning production. Include the following items in the QCP:

1. **Project Personnel.** For project personnel, include:
   - a list of individuals responsible for QC with authority to take corrective action, and
   - contact information for each individual listed.

2. **Material Delivery and Storage.** For material delivery and storage, include:
   - the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations,
   - aggregate stockpiling procedures to avoid contamination and segregation,
   - frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production, and
   - procedure for monitoring the quality and variability of asphalt binder 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, lime, liquid anti-strip),
   - 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 pre-paving meeting, including date and location
   - type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils,
   - procedures for the transfer of mixture into the paver while avoiding segregation and preventing material spillage,
   - process to balance production, delivery, paving, and compaction to achieve continuous placement operations,
   - paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities, and
   - procedures to construct quality longitudinal and transverse joints.

D. Mixture Design.

1. Design Requirements. Unless otherwise shown on the plans, use Tex-247-F to design a mixture meeting the requirements listed in Tables 1, 6 and 7. Use Ndes = 50 as the design number of gyrations. Design the mixture with an air void structure that will accommodate a membrane application rate in conformance with Table 9.

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,
- ignition oven correction factors for asphalt content and gradation,
- the mixing and molding temperatures,
- the signature of the Level II person or persons that performed the design,
- the date the mixture design was performed, and
- a unique identification number for the mixture design.

Table 6
Master Gradation Bands (% Passing by Weight) and Binder Content

Sieve Size		Type A	Type B	Type C
(inch)	(mm)	Gradation	Gradation	Gradation
3/4 in.	19			100*
1/2 in.	12.7		100	75–100
3/8 in.	9.5	100	75–100	55–80
4	4.75	35–55	22–36	22–36
8	2.36	19–30	19–30	19–30
16	1.18	14–25	14–24	14–24
30	0.60	10–18	10–18	10–18
50	0.30	7–14	7–14	7–14
100	0.15	5–10	5–10	5–10
200	0.075	4–6	4–6	4–6
AC Content %		5.0-5.8	4.8-5.6	4.6–5.6

* A target of 100% passing the 5/8 in. is recommended. Mixtures containing 5/8 in. aggregate size may require a greater paving thickness.

Table 7
Laboratory Mixture Design Properties

Mixture Property	Test Method	Minimum	Maximum
Film Thickness, microns	Tex-247-F	9	–
Drain-down, %	Tex-235-F	–	0.1
Cantabro Loss (unaged), %	Tex-245-F	–	20.0[1]
Boil test	Tex-530-C	Pass/Fail	None
Membrane Application Rate, gal/sy	Tex-247-F	Report	Report
Laboratory-molded density, %	Tex-207-F, Part VI	85[2]	92

1. Test and report for informational purposes only.
2. Suggested limit**.** Test and report for informational purposes only.

2. 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) Submitting JMF1. Furnish the Engineer a mix design report (JMF1) and request approval to produce the trial batch.

(2) Membrane Target Application Rate. Provide the Engineer the emulsion membrane target application rate calculated from JMF1.

(3) Supplying Aggregates. Provide the Engineer with approximately 40 lb. of each aggregate stockpile unless otherwise directed.

(4) Supplying Asphalt. Provide the Engineer at least 1 gal. of the asphalt material and sufficient quantities of any additives proposed for use.

(5) Ignition Oven Correction Factors. Determine the aggregate and asphalt correction factors from the ignition oven using Tex-236-F. Base correction factors from washed sieve analysis as required by the mix design. Provide the Engineer with split samples of the mixtures and blank samples used to determine the correction factors.

(6) 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 commercial anti-stripping agents (liquid anti-strip) as directed.

(7) 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.

(8) Trial Batch Production Equipment. To produce the trial batch, use only equipment and materials proposed for use on the project.

(9) Trial Batch Quantity. Produce enough quantity of the trial batch to ensure that the mixture is representative of JMF1.

(10) Number of Trial Batches. Produce trial batches as necessary to obtain a mixture that meets the operational tolerances in Table 8.

(11) 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.

(12) 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 8. Apply correction factors determined in Section 4.D.2.a.(5) to JMF1 results for gradation and asphalt content. Provide the Engineer with a copy of the trial batch test results.

(13) 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.

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

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

(16) 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 8, and
- be within the operational tolerances of JMF2 listed in Table 8.

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

Table 8
Testing Frequency and Mixture Production Tolerances

Test Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency	Operational Tolerance from JMF
% Passing for sieve sizes larger than #4	Tex-200-F	1 per sublot	1 per 4 lots	+/-5.0
% Passing #4 and #8	Tex-200-F	1 per sublot	1 per 4 lots	+/-4.0
% Passing #16, #30 and #50	Tex-200-F	1 per sublot	1 per 4 lots	+/-3.0
% Passing#100	Tex-200-F	1 per sublot	1 per 4 lots	+/-2.0
% Passing #200	Tex-200-F	1 per sublot	1 per 4 lots	See Note 1
Binder Content, %	Tex-236-F	1 per sublot	1 per 4 lots	+/-0.3
Rice Gravity	Tex 227-F	1 per lot	1 per 4 lots	See Note 3
Drain-down, %	Tex-235-F	1 per sublot	1 per 4 lots	Table 5
Boil Test[2]	Tex-530-C	1 per project	1 per project	N/A
Membrane Application Rate	Tex-247-F	1 per lot	1 per 4 lots	+/-0.02
Asphalt Binder Sampling[2]	Tex-500-C	1 per sublot (sample only)	1 per project	N/A
Emulsion Membrane Sampling[2]	Tex-500-C	1 per lot (sample only)	1 per project	Table 4
Lab molded density	Tex-207-F Part VI	1 per sublot	1 per 4 lots	Table 7
Thermal profile	Tex-244-F	1 per sublot	Optional	N/A

1. Take corrective action if aggregate gradation exceeds limits shown in Table 8.
2. The Engineer may reduce or waive the sampling and testing requirements based on a satisfactory test history.
3. Used to calculate density.

b. Engineer's Responsibilities.

(1) Gyratory Compactor. For molding trial batch samples, the Engineer will use the Contractor-provided SGC at the Contractor's field laboratory or provide and use a Department SGC at an alternate location.

(2) Conditional Approval of JMF1. Within two 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 one full working day, the Engineer will sample and test the trial batch to ensure that the gradation and binder content meet the requirements listed in Table 8. Apply correction factors

determined in Section 4.D.2.a.(5) to JMF1 results for gradation and asphalt content.

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 7.
- Tex-461-A to determine the need for additional magnesium sulfate soundness testing.
- Tex-530-C to retain and use for comparison purposes during production.
- Tex-245-F to verify the Cantabro loss meets the requirement shown in Table 7.

(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 and asphalt content confirm that the trial batch meets the requirements in Table 8.

The Engineer will notify the contractor that an additional trial batch is required if the trial batch does not meet the requirements in Table 8.

(7) Approval JMF2. The Engineer will approve JMF2 within one working day if it meets the master grading limits shown in Table 6 and is within the operational tolerances of JMF1 listed in Table 8.

(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 6 and is within the operational tolerances of JMF2 listed in Table 8.

2. JMF Adjustments. Produce the mixture within the operational tolerances listed in Table 8. 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 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 8. 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:

- Additives:
  - lime (within ± 0.1% of JMF)
  - liquid anti-strip (within ± 0.05% of JMF)
- Emulsion membrane application rate (within ± 0.02 gal/sy of JMF)

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 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. Unless otherwise approved, do not store hot mix for more than 6 hrs. or a period that adversely 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 350ºF.

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

F. Hauling Operations. Before use, clean all truck beds to ensure mixture is not contaminated. When a release agent is necessary, use a release agent on the approved list maintained by the Construction Division to coat the inside bed of the truck.

G. Placement Operations. Prepare the surface by removing raised pavement markers and objectionable material such as moisture 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 UTBHMWC 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 ensure that the membrane is exposed for no more than 5 seconds before being covered with UTBHMWC. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. When placing the hot mix adjacent to gutters and structures to ensure that the pavement will drain properly.

1. **Weather Conditions.** Place the mixture when the roadway surface temperature is 70°F or higher, unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. 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 mixture design within the limits shown in Table 9. The Engineer may adjust the application rate, taking into consideration the existing pavement surface conditions. Spray the membrane using a metered mechanical pressure spray bar at a temperature of 120ºF to 180ºF. Monitor the membrane application rate and adjust 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 9
Membrane Application Rate Limits, (gallons per square yard)

Type A	Type B	Type C
0.14 – 0.20	0.16 – 0.24	0.17 – 0.27

3. **Lay-Down Operations.** Measure the temperature of mixture delivered to the paver and take corrective action if needed to ensure the temperature does not drop below 290°F.

   For each sublot 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. The Engineer may reduce the testing frequency based on a satisfactory test history.

   a. **Thermal Profile.** For each sublot, 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 between 25°F and 50°F, the area will be deemed as having thermal segregation. Take corrective action to eliminate areas that have thermal segregation.

H. Compaction. Roll the freshly placed UTBHMWC 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. Compact the wearing course a minimum of two passes and a maximum of three passes. 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.

I. Acceptance Plan. Sample and test the hot mix on a lot and sublot basis. A production lot consists of four equal sublots. Lot 1 will be 500 tons or one day's production. The Engineer will select subsequent lot sizes based on the anticipated daily production. The lot size will be at least 500 tons, but no greater than 2000 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 8, 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 8 and the differences cannot be resolved. Make the request within five working days after receiving test results from the Engineer. Referee tests will be performed only on the lot in question and only for the particular test in question. Allow ten 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 three 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. Production Acceptance.

a. Mixture Sampling. For each sublot, take one sample at the location randomly selected. For each lot, the Engineer will randomly select and test a "blind" sample from at least one sublot. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

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

b. Asphalt Binder Sampling. Obtain a 1-qt. 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. Supply a sampling port between any additive blending device and mixer. Locate the sampling port downstream of any additive addition so the sample will be a representation of the final asphalt-additive blend going to the roadway. 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 sublot 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 one asphalt binder sample per project to verify compliance with Item 300.

c. Operational Tolerances. Control the production process within the operational tolerances listed in Table 8. 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.

3. Placement Acceptance.

a. Emulsion Membrane Sampling. Obtain a 1-qt. sample of the polymer-modified emulsion for each sublot of mixture produced. Take the sample from the emulsion tank located on the paving machine, but not from the emulsion spraybar. Obtain the sample at approximately the same time the mixture random sample is obtained. Take the sample in accordance with Tex-500-C, Part III. Label the can with the corresponding lot and sublot numbers, and deliver the sample to the Engineer.

b. 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.

c. 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 one 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.

4. Ride Quality. Unless otherwise shown in the plan, measure ride quality in accordance with Item 585.

5. Measurement. Ultra Thin-Bonded Hot Mix Wearing Course (UTBHMWC) will be measured by the ton of UTBHMWC. UTBHMWC is defined as the asphalt, aggregate, and

additives. The weights of asphalt and aggregate will be calculated based on the measured weight of UTBHMWC and the target percentage of asphalt and aggregate. Measure the weight on scales in accordance with Item 320. Measure the UTBHMWC polymer modified emulsion membrane by the gallon or the ton, in accordance with the bid item specified.

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 pavement will be the number of gallons used corrected to 60°F, as directed, in the accepted surface treatment.

2. Weight. Membrane material will be measured in tons using certified scales meeting the requirements of Item 320, 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 items.

B. Asphalt. The asphalt weight in tons will be determined from the total weight of UTBHMWC. Measured asphalt percentage will be obtained using Tex-236-F or asphalt flow meter readings, as determined by the Engineer.

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 60^{o}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 UTBHMWC less the weight of the asphalt.

6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under Section 4.I.5 will be paid for at the unit price bid for "UTBHMWC (Membrane)," for "UTBHMWC (Asphalt)," and for "UTBHMWC (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.