SPECIAL SPECIFICATION

3226

Thin Friction Course Overlay (TFCO) Mixture

1. Description. Construct a thin friction course overlay surface mix composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant and placed at a lift thickness of 3/4 to 1 inch.

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

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

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

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

When 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 that at least 50% by weight of material retained on the No. 8 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.

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	AQMP	Note 1
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 2
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[3]
Flat and elongated particles @ 5:1, %, max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, max	Tex-107-E	3
Combined Aggregate[4]		
Sand equivalent, %, min	Tex-203-F	45

1. Surface aggregate classification of "A" is required unless otherwise shown on plans.
2. Not used for acceptance purposes. Used by the Engineer as an indicator of the need for further investigation.
3. Only applies to crushed gravel.
4. Aggregates, without mineral filler, or additives, combined as used in the job-mix formula (JMF).

2. Fine Aggregate. Fine aggregates consist of manufactured sands and screenings. Natural sands are not allowed in any mixture. 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 that the material is free from organic impurities. Use fine aggregate from coarse aggregate sources that meet the requirements 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 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Weight or Volume
3/8"	98 - 100
#8	70 – 100
#200	0 – 30

3. **Recycled Asphalt**. Do not use recycled asphalt from RAP or RAS, unless approved otherwise.

4. **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% mineral hydrated lime, unless otherwise shown on the plans. Do not add lime or cement directly into the mixing drum of any plant where they are removed through the exhaust stream, unless the plant has a baghouse or dust collection system that reintroduces them back into the drum.

   When used, provide mineral filler that:

   - is sufficiently dry, free-flowing and free from clumping and foreign matter;
   - does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E (not applicable for hydrated lime or fly ash); 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

B. Baghouse Fines. Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

C. Asphalt Binder. Furnish performance-graded (PG) asphalt binder of PG 76 in accordance with Section 300.2.J, "Performance-Graded Binders." Unless otherwise shown on the plans, the contractor may use a substitute PG binder of PG 70-22 in lieu of the PG 76 binder, if the substitute PG binder and mixture made with the substitute PG binder meet the following:

- the substitute binder meets the specification requirements for a PG 70-22 in accordance with Section 300.2.J, "Performance-Graded Binders;"
- the substitute binder has an un-aged dynamic shear value less than or equal to 2.00 kPa and an RTFO aged dynamic shear value less than or equal to 5.00 kPa at the PG test temperature; and
- the mixture has less than 10.0 mm of rutting on the Hamburg Wheel test (Tex-242-F) after the number of passes required for the originally specified binder. Use of the substitute PG 70-22 binder may only be allowed at the discretion of the Engineer if the Hamburg Wheel test results are between 10.0 mm and 12.5 mm.

D. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS-1P, SS-1P, or a PG binder with a minimum high-temperature grade of PG 58 for the tack coat binders, in accordance with Item 300, "Asphalts, Oils, and Emulsions." Do not dilute emulsion 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 and test it to verify compliance with Item 300. The Engineer will obtain the sample from the asphalt distributor immediately before use.

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. Antistripping Agent. If lime or liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." When the plans require lime to be added as an antistripping agent, hydrated lime added as mineral filler will count towards the total quantity of hydrated lime specified. No more than 1% hydrated lime will be added to any mixture.

2. Warm Mix Asphalt (WMA). WMA is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed. WMA is allowed for use at the Contractor's option, unless otherwise shown on the plans. The use of WMA is required when shown on plans. When WMA is required, produce an asphalt mixture within the temperature range of 215ºF and 275ºF. When WMA is not required as shown on the plans, produce as asphalt mixture within the temperature range of 215ºF and 350ºF. When producing WMA with a foaming system, do not produce the WMA at temperatures below 250ºF, unless otherwise approved. Unless otherwise directed, use only WMA additives or processes appearing on the Construction Division's Material Producer List, "Warm Mix Asphalt," (http://www.txdot.gov/txdot_library/publications/producer_list.htm.)

5. Equipment. Provide required or necessary equipment in accordance with Item 320, "Equipment for Hot-Mix Asphalt Materials."

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

A. Certification. Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 4. 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 developed and signed by a Level II certified specialist. Provide a Level IA certified specialist at the plant during production operations. Provide a Level IB certified specialist to conduct placement tests.

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

1. Aggregate Testing	Test Method	Contractor	Engineer	Level
Sampling	Tex-400-A	✓	✓	IA
Dry sieve	Tex-200-F, Part I	✓	✓	IA
Washed sieve	Tex-200-F, Part II	✓	✓	IA
Deleterious material	Tex-217-F, Part I	✓	✓	II
Decantation	Tex-217-F, Part II	✓	✓	II
Los Angeles abrasion	Tex-410-A		✓	
Magnesium sulfate soundness	Tex-411-A		✓	
Micro-Deval abrasion	Tex-461-A		✓	
Coarse aggregate angularity	Tex-460-A	✓	✓	II
Flat and elongated particles	Tex-280-F	✓	✓	II
Linear shrinkage	Tex-107-E	✓	✓	II
Sand equivalent	Tex-203-F	✓	✓	II
Organic impurities	Tex-408-A	✓	✓	II
2. Mix Design & Verification	**Test Method**	**Contractor**	**Engineer**	**Level**
Design and JMF changes	Tex-204-F	✓	✓	II
Mixing	Tex-205-F	✓	✓	II
Molding (TGC)	Tex-206-F	✓	✓	IA
Laboratory-molded density	Tex-207-F	✓	✓	IA
VMA	Tex-207-F	✓	✓	II
Rice gravity	Tex-227-F	✓	✓	IA
Ignition oven calibration[1]	Tex-236-F	✓	✓	II
Indirect tensile strength	Tex-226-F	✓	✓	II
Overlay Test	Tex-248-F		✓	
Hamburg Wheel test	Tex-242-F	✓	✓	II
Boil test	Tex-530-C	✓	✓	IA
3. Production Testing	**Test Method**	**Contractor**	**Engineer**	**Level**
Random sampling	Tex-225-F		✓	IA
Mixture sampling	Tex-222-F	✓	✓	IA
Molding (TGC)	Tex-206-F	✓	✓	IA
Laboratory-molded density	Tex-207-F	✓	✓	IA
VMA (calculation only)	Tex-207-F	✓	✓	IA
Rice gravity	Tex-227-F	✓	✓	IA
Gradation & asphalt content[1]	Tex-236-F	✓	✓	IA
Control charts	Tex-233-F	✓	✓	IA
Moisture content	Tex-212-F	✓	✓	IA
Hamburg Wheel Test	Tex-242-F	✓	✓	II
Micro-Deval abrasion	Tex-461-A		✓	
Boil Test	Tex-530-C	✓	✓	IA
Aging Ratio	Tex-211-F		✓	
4. Placement Testing	**Test Method**	**Contractor**	**Engineer**	**Level**
Random sampling	Tex-225-F		✓	IA
Establish rolling pattern	Tex-207-F	✓		IB
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		✓	IB

1. Refer to Section 4.I.2.c for exceptions to using an ignition oven.

B. Reporting. Use Department-provided software to record and calculate all test data. Obtain the latest version of the software from the Engineer or from http://www.dot.state.tx.us/txdot_library/consultants_contractors/forms/site_manager.htm.

The Engineer and the Contractor must 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 4a unless otherwise approved. The Engineer and the Contractor shall immediately report to the other party any test result that requires production to be suspended, requires a payment penalty, or fails to meet the specification requirements. Record and submit all test results and pertinent information on Department-provided software to the Engineer electronically by means of a portable USB flash drive or diskette, or via email.

Table 4a
Reporting Schedule

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

1. These tests are required on every sublot.
2. Optional test. To be reported as soon as results become available.
3. To be performed at the frequency specified on the plans.
4. Additional time is allowed if cores can not be dried to constant weight within 1 day.

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

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

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

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

1. **Project Personnel.** For project personnel, include:
   - a list of individuals responsible for QC with authority to take corrective action; and
   - contact information for each individual listed.
2. **Material Delivery and Storage.** For material delivery and storage, include:
   - the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
   - aggregate stockpiling procedures to avoid contamination and segregation;
   - frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
   - procedure for monitoring the quality and variability of asphalt binder.
3. **Production.** For production, include:
   - loader operation procedures to avoid contamination in cold bins;
   - procedures for calibrating and controlling cold feeds;
   - procedures to eliminate debris or oversized material;
   - procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, lime, liquid antistrip);
   - procedures for reporting job control test results; and
   - procedures to avoid segregation and drain-down in the silo.
4. **Loading and Transporting.** For loading and transporting, include:
   - type and application method for release agents; and
   - truck loading procedures to avoid segregation.
5. **Placement and Compaction.** For placement and compaction, include:
   - proposed agenda for mandatory prepaving meeting, including date and location;
   - type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
   - procedures for the transfer of mixture into the paver, while avoiding segregation and preventing material spillage;
   - process to balance production, delivery, paving, and compaction to achieve continuous placement operations;
   - paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
   - procedures to construct quality longitudinal and transverse joints.

D. Mixture Design.

1. **Design Requirements.** Use the mix design for dense-graded hot-mix asphalt mixtures using the Texas Gyratory Compactor (TGC) given in Tex-204-F,

Part I. Design a mixture meeting the requirements listed in Tables 1, 2, 3, 5, and 6.

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. Evaluate the mixture using the Hamburg Wheel Test at the optimum asphalt content (OAC) and at OAC + 0.5%. The Construction Division maintains a list of approved laboratories. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the laboratory mixture design.

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

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 5
Master Gradation Bands (% Passing by Weight or Volume) and Volumetric Properties

Sieve Size	Fine Mixture (% Passing by Weight or Volume)
3/4"	–
1/2"	100.0
3/8"	85.0 – 100.0
#4	40.0 – 60.0
#8	17.0 – 27.0
#16	5.0 – 27.0
#30	5.0 – 27.0
#50	5.0 – 27.0
#200	5.0 – 9.0
Property	**Requirement**
Binder Content, % Minimum	6.0
Design VMA[1], % Minimum	16.0
Plant-Produced VMA, % Minimum	15.5

1. Voids in mineral aggregates.

Table 6
Laboratory Mixture Design Properties

Property	Test Method	Requirement
Target Laboratory-Molded Density, %	Tex 207 F	97.5
Hamburg Wheel Tracking Test, Min. passes [1]	Tex 242-F	20,000
Tensile Strength (dry), psi. [2]	Tex-226-F	85-180
Lime Content, Max %		1.0
Drain Down Test, Max %	Tex 235 - F	0.20

1. Mold test specimens to 93%+/- 1% as per Tex 242-F.
2. May exceed 180 psi when approved and may be waived when approved.

2. Job-Mix Formula Approval. The job-mix formula (JMF) is the combined aggregate gradation and target asphalt percentage used to establish target values for hot mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. 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 a 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 Gyratory Compactor. Furnish a Texas Gyratory Compactor (TGC), calibrated in accordance with Tex-914-F, for molding production samples. Locate the TGC at the Engineer's field laboratory and make the TGC 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 TGC. Apply the correlation factor to all subsequent production test results.

(3) Submitting JMF1. Furnish the Engineer a mix design report (JMF1), and request approval to produce the trial batch. If opting to have the Department perform the Hamburg Wheel test on the laboratory mixture, provide the Engineer with approximately 10,000 g of the design mixture and request that the Department perform the Hamburg Wheel test.

(4) Supplying Aggregate. 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. Provide the Engineer with split samples of the mixtures,

including all additives (except water), and blank samples used to determine the correction factors. 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. 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 the trial batch mixture with an asphalt content within 0.5% of the optimum asphalt content established for JMF1, unless otherwise approved.

Obtain and provide the Engineer with approximately 10,000 g of trial batch mixture in a sealed container, box, or bags labeled with the CSJ number, mixture type, and date for Hamburg testing.

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

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

(11) Number of Trial Batches. Produce trial batches as necessary to obtain a mixture that meets the requirements in Table 7.

(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 that the mixture produced using the proposed JMF1 meets the verification testing requirements for gradation, asphalt content, laboratory-molded density, and VMA listed in Table 8 and is in compliance with the Hamburg Wheel and Overlay test requirements in Tables 6 an 7. Use an approved laboratory to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

(14) Development of JMF2. After the Engineer grants full approval of JMF1 based on results from the trial batch, evaluate the trial batch test results, determine the optimum mixture proportions, and submit as JMF2. Adjust the asphalt content 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 shown in Table 5.

(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 and the Department's Overlay test on the trial batch, use JMF2 to produce Lot 1. As an option, once JMF2 is approved, proceed to Lot 1 production at the Contractor's risk without receiving the results from either the Department's Hamburg Wheel test on the trial batch. If electing to proceed without the Hamburg Wheel test results from the trial batch, notify the Engineer. Note that the Engineer may require that up to the entire sublot 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 on a new lot;
- be numbered in sequence to the previous JMF;
- meet the master gradation limits shown in Table 5; and
- be within the operational tolerances of JMF2 listed in Table 7.

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

Table 7
Operational Tolerances

Description	Test Method	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and Engineer[1]
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±3.0[2]	±3.0
Individual % retained for sieves smaller than #8 and larger than #200		±3.0[2]	±3.0
% passing the #200 sieve		±2.0[2]	±1.6
Asphalt content, %[5]	Tex-236-F	±0.3[3]	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±0.5
Laboratory-molded bulk specific gravity		N/A	±0.020
VMA, % min		Note 4	N/A
Drain-down, %	Tex-235-F	±0.10	±0.10
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	± 0.020

1. Contractor may request referee testing only when values exceed these tolerances.
2. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 sieve will be considered out of tolerance when outside the master grading limits.
3. Tolerance between trial batch test results and JMF1 (lab produced mix) is not allowed to exceed 0.5%, unless otherwise directed. Tolerance between JMF1 (lab produced mix) and JMF2 is allowed to exceed ±0.3%.
4. Test and verify that Table 5 requirements are met.
5. May be obtained from asphalt meter readouts for Type I

b. Engineer's Responsibilities.

(1) Gyratory Compactor. The Engineer will use a Department TGC, calibrated in accordance with Tex-914-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided TGC at the field laboratory or will provide and use a Department TGC at an alternate location. The Engineer will make the Contractor-provided TGC in the Department field laboratory available to the Contractor for molding verification samples.

(2) Conditional Approval of JMF1. When the Contractor is required to perform the mixture design as shown on plans, within 10 working days of receiving the mixture design report (JMF1) and all required materials and Contractor-provided Hamburg Wheel test results, the Engineer will review the Contractor's mix design report and verify conformance with all aggregates, asphalt, additives, and mixture specifications. The Engineer may perform tests to verify that 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 that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test results with laboratory mixture design, allow the Engineer 10 working days for conditional approval of JMF 1. The Engineer will base full approval of JMF1 on test results on mixture from the trial batch.

(3) Hamburg Wheel Testing of JMF1. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the laboratory mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 6.

(4) Authorizing Trial Batch. After conditionally approving JMF1, including either Contractor- or Department-supplied Hamburg Wheel test results, the Engineer will authorize the Contractor to produce a trial batch.

(5) Ignition Oven Correction Factors. The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven in accordance with Tex-236-F.

(6) Testing the Trial Batch. Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the gradation, asphalt content, laboratory-molded density, and VMA meet the requirements listed in Table 7. 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 6.

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

- Tex-226-F, to verify that the indirect tensile strength meets the requirement shown in Table 6.
- Tex-235-F, to verify that drain-down meets the requirements shown in Table 6;
- Tex-461-A, to determine the need for additional magnesium sulfate soundness testing; and
- Tex-530-C, to retain and use for comparison purposes during production.

(7) Full Approval of JMF1. The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for gradation, asphalt content, laboratory-molded density, and VMA confirm that the trial batch meets the requirements in Table 7.

The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet the requirements in Table 5.

(8) Approval of JMF2. The Engineer will approve JMF2 within 1 working day if the gradation meets the master grading limits shown in Table 5 and is within the operational tolerances of JMF1 listed 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 5.

(9) Approval of Lot 1 Production. The Engineer will authorize the Contractor to proceed with Lot 1 production as soon as a passing result is achieved from the Department's or an approved laboratory's Hamburg Wheel test. As an option, the Contractor may, at their own risk, proceed with Lot 1 production without results from the Hamburg Wheel test on the trial batch.

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

(10) Approval of JMF3. The Engineer will approve JMF3 within 1 working day if it meets the master grading limits shown in Table 5 and is within the operational tolerances of JMF2 listed in Table 7.

E. Production Operations. Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification.

1. Storage and Heating of Materials. Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. On a daily basis, provide the Engineer with the records of asphalt binder and hot-mix asphalt discharge temperatures in legible increments in accordance with Item 320, "Equipment for Hot-Mix Asphalt Materials." Unless otherwise approved, do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr.

2. Mixing and Discharge of Materials. 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.

When WMA is specified on the plans, produce the mixture and monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 275° F or is less than 215° F. When WMA is not specified but used at the Contractor's discretion, the Department will not pay for or allow placement of any WMA produced at more than 350°F or less than 215°F, unless otherwise directed. When WMA is not required as shown on plans and

is not used by the Contractor, produce an asphalt mixture within the temperature range of 275°F and 350°F.

F. Hauling Operations. Before use, clean all truck beds to ensure that 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. 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, unless otherwise shown on the plans. When the Pave-IR system is not used for specification compliance, measure and record the internal temperature of the mixture as discharged from the truck or material transfer device prior to entering the paver and an approximate station number on each ticket, unless otherwise shown on plans. Unless otherwise directed, calculate and report the yield and cumulative yield following the production of every 125 tons or following every 2 hours of production, whichever occurs first for the specified lift and provide to the Engineer. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations.

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 that longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly. Place mixture within the compacted lift thickness shown in Table 8, unless otherwise shown on the plans or allowed.

Table 8
Compacted Lift Thickness and Required Core Height

Compacted Lift Thickness		Minimum Untrimmed Core Height (in.) Eligible for Testing
Minimum (in.)	Maximum (in.)	
0.75	1.0	N/A

1. Weather Conditions. Place when the roadway surface temperature is equal to or higher than 60ºF, unless otherwise approved or shown on the plans. Measure the roadway surface temperature with a handheld infrared thermometer or infrared camera. 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 hrs. of beginning placement operations. Unless otherwise shown on the plans, place mixture only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

Contractors may pave at temperatures as low as 50°F when utilizing a paving process or equipment that eliminates thermal segregation. In such cases, the contractor must use either an infrared bar attached to the paver, a hand held

thermal camera, or a hand held infrared thermometer operated in accordance with Tex-244-F to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

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 0.12 and 0.16 gal. of residual asphalt per square yard of surface area. Apply a 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 when directed. The Engineer may use Tex-243-F to verify that the tack coat has adequate adhesive properties. The Engineer may suspend paving operations until there is adequate adhesion.

3. **Lay-Down Operations.** When WMA is not used, measure the temperature of the mixture delivered to the paver and take corrective action if needed to ensure the temperature does not drop below 290 ºF.

    a. **Thermal Profile.** Use an infrared thermometer or thermal camera to obtain a thermal profile on each sublot in accordance with Tex-244-F. The Engineer may allow the Contractor to reduce the testing frequency based on a satisfactory test history. The Engineer may also obtain as many thermal profiles as deemed necessary. Thermal profiles are not applicable in miscellaneous paving areas subject to hand work such as driveways, crossovers, turnouts, gores, tapers, and other similar areas.

        (1) Moderate Thermal Segregation. Any areas that have a maximum 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 a density profile in accordance with Section 4.I.3.c(2), "Segregation Density Profile)."

        (2) Severe Thermal Segregation. Any areas that have a maximum temperature differential greater than 50°F are deemed as having severe thermal segregation. When the Pave-IR system is not used, no production or placement bonus will be paid for any sublot that contains severe thermal segregation. Unless otherwise directed, suspend operations and take immediate corrective action to eliminate severe thermal segregation. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Item. Evaluate areas with severe thermal segregation by performing a density profile in accordance with Section 4.I.3.c(2), "Segregation (Density Profile)." Unless otherwise directed, remove and replace the material in any areas that have both severe thermal segregation and a failing result for Segregation (Density Profile). The sublot 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 sublot using an infrared thermometer or thermal camera, 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 more than 24 hours from the start of production 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 an infrared thermometer or thermal camera to obtain thermal profiles in accordance with Tex-244-F.

When using the Pave-IR system, review the output results on a daily basis and, unless otherwise directed, provide the output results to the Engineer for review. Modify the paving process as necessary to eliminate any (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 thermal segregation. 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 which 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.

H. Compaction. Roll with a steel-wheel roller without excessive breakage of the aggregate and to provide a smooth surface and uniform texture. Do not use pneumatic-tire rollers or steel-wheel roller in vibratory mode. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern. Thoroughly moisten the roller drums with soap and water solution to prevent adhesion. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment.

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.

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 sublot basis at the frequency shown in Table 9. A production lot consists of four equal sublots. Lot 1 will be 500 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production. The lot size will be between 500 tons and 2,000 tons.

The Engineer may change the lot size before the Contractor begins any lot. If production or placement test results are not within the acceptable tolerances listed in Table 7, 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.

Table 9
Production and Placement Testing Frequency

Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	1 per sublot	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 sublot
VMA			
Laboratory-molded bulk specific gravity			
Moisture content	Tex-212-F, Part II	When directed	
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	1 per sublot
Asphalt content	Tex-236-F	1 per sublot	1 per lot
Hamburg Wheel test	Tex-242-F	N/A	1 per project
Thermal profile	Tex-244-F	1 per sublot	
Asphalt binder sampling and testing[1]	Tex-500-C	1 per sublot (sample only)	
Boil test[1]	Tex-530-C	1 per lot	

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

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 tolerance shown in Table 7 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 sublot in question and only for the particular test in question. Allow 10 working days from the time the referee laboratory receives the samples for reporting of test results. 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.

2. **Production Acceptance.**

   a. **Production Lot.** A production lot consists of four equal sublots. Lot 1 will be 500 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production. The lot size will be between 500 tons and 2,000 tons. The Engineer may change the lot size before the Contractor begins any lot.

(1) Small-Quantity Production. When the anticipated daily production is less than 500 tons, the Engineer may waive all production and placement testing; however, the Engineer will retain the right to perform random acceptance tests for production and placement and may reject objectionable materials and workmanship.

When the Engineer waives all production and placement sampling and testing requirements:

- produce, haul, place, and compact the mixture as directed by the Engineer;
- control mixture production to yield a laboratory-molded density as indicated in Table 6 for the mixture type being produced to ± 1.0% as tested by the Engineer; and

(2) Incomplete Production Lots. If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot.

b. Production Sampling.

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

Obtain hot mix samples from trucks at the plant in accordance with Tex-222-F. For each sublot, take one sample at the location randomly selected. The Engineer will witness the sampling. For each lot, the Engineer will randomly select, obtain 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." The Engineer will 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 testing by the Department is completed. Discard unused samples after the Engineer has accepted the material for payment.

(2) Tack Coat 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. 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.

(3) Asphalt Binder Sampling. Obtain a 1 qt. sample of the asphalt binder for each sublot of mixture produced. Obtain the sample at approximately the same time the mixture random 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 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, "Asphalts, Oils, and Emulsions."

c. Production Testing. The Contractor and Engineer must perform production tests in accordance with Table 10. 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 7 for all sublots.

Control mixture production to yield a laboratory-molded density as indicated in Table 6 for the mixture type being produced to ± 1.0% as tested by the Engineer. Suspend production if two consecutive sublots fail to meet this requirement, unless otherwise approved. Resume production after the Engineer approves changes to production methods.

Referee testing is required for any sublot with a laboratory-molded density greater than 99.0% or less than 96.5%. If the new laboratory-molded density is within the range of 96.5% to 99.0%, the material will receive full payment in accordance with Sections 5.A and 5.B. If the new laboratory-molded density is not within the range of 96.5% to 99.0%, the Engineer may require removal and replacement or may allow the sublot to be left in place without payment or at a reduced payment. Replacement material meeting the requirements of this Item will be paid for in accordance with this Article.

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.

d. Operational Tolerances. Control the production process within the operational tolerances listed in Table 7. When production is suspended, the Engineer will allow production to resume when test results or other information indicates that the next mixture produced will be within the operational tolerances.

(1) Gradation. Unless otherwise directed, suspend production when either the Contractor's or the Engineer's test results for gradation exceed the operational tolerances for 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. Unless otherwise directed, suspend production when two or more sublots within a lot are out of operational tolerance for asphalt content based on either the Contractor's or the Engineer's test results. Suspend production and shipment of mixture if the asphalt content deviates from the current JMF by more than 0.5% for any sublot.

(3) Hamburg Wheel Test. The Engineer may perform a Hamburg Wheel test at any time during production, including when the boil test indicates a change in quality from the materials submitted for JMF1. In addition to testing production samples, the Engineer may obtain cores and perform the Hamburg Wheel test on any area of the roadway where rutting is observed. The Engineer may require up to the entire sublot of any mixture failing the test to be removed and replaced at the Contractor's expense.

If the Department's or Department-approved laboratory's Hamburg Wheel test results do not meet the minimum number of passes specified in Table 6, the Contractor may request that the Department confirm the results by retesting the failing material. The Construction Division will perform the Hamburg Wheel tests and determine the final disposition of the material in question based on the Department's test results.

e. Individual Loads of Mix. The Engineer can reject individual truckloads of mix. When a load of mix is rejected for reasons other than temperature, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 7, 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 sublot consists of the area placed during a production sublot.

(1) Incomplete Placement Lots. An incomplete placement lot consists of the area placed as described in Section 4.I.2.a.(2), "Incomplete Production Lots," excluding miscellaneous areas as defined in Section 4.I.3.a(3), "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production sublot.

b. Placement Testing. The allowable differences between the Contractor's and Engineer's test results are listed in Table 7.

(1) **Recovered Asphalt Dynamic Shear Rheometer (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 T 315 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 in accordance with Tex-211-F.

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

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

8. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under Article 3226.7, "Measurement," will be paid for at the unit price bid for "Thin Friction Course Overlay," of the mixture type, surface aggregate classification, and binder specified. Pay adjustments for bonuses and penalties will be applied for production as determined in this Item. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals.

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

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

A. Production Pay Adjustment Factors. The production pay adjustment factor is based on the laboratory-molded density using the Engineer's test results. A pay adjustment factor will be determined from Table 10 for each sublot using the deviation from the target laboratory-molded density defined in Table 6. The production pay adjustment factor for completed lots will be the average of the pay adjustment factors for the 4 sublots sampled within that lot.

Table 10
Production Pay Adjustment Factors for Laboratory-Molded Density

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

1. **Incomplete Production Lots.** Production pay adjustments for incomplete lots, described under Section 3226.3.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 sublot results in a "remove and replace" condition as listed in Table 10, the Engineer may require removal and replacement, or may allow the sublot to be left in place without payment. Replacement material meeting the requirements of this Item will be paid for in accordance with this Article.

B. Placement Pay Adjustment Factors. A placement pay adjustment factor of 1.000 will be assigned to each sublot.

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

$TAP = (A+B)/2$

Where:

A = Bid price × production lot quantity × average pay adjustment factor for the production lot
B = Bid price × placement lot quantity × 1.000