APPENDIX A1

State Test Case #1, Florida:

FDOT SECTION 334A

Airport Pavement for <60,000# AGW

FDOT SECTION 334A

SUPERPAVE ASPHALT CONCRETE
AIRPORT PAVEMENT FOR <60,000# AIRCRAFT GROSS WEIGHT

SECTION 334 SUPERPAVE ASPHALT CONCRETE, inclusive, and all other referenced parts of Florida Department of Transportation, Standard Specifications for Road and Bridge Construction, Current Edition, are applicable under this **SECTION 334A**, except as modified herein.

Equivalent Terms for this Specification, and throughout application of Florida Department of Transportation, Standard Specifications for Road and Bridge Construction, Current Edition, are listed below:

Department, synonymous with Airport Owner [or Owner Authorized Representative]

Engineer, synonymous with Airport Owner [or Owner Authorized Representative]

State Materials Engineer, synonymous with Airport Owner [or Owner Authorized Representative]

Roadway, synonymous with Airport Pavement

Delete Subsection 334-1.2 and substitute the following:

334-1.2 Traffic Levels: The requirements for Type SP Asphalt Concrete mixtures are based on the design traffic level of the project, expressed in 18,000 pound Equivalent Single Axle Loads (ESAL's) equated to Aircraft Gross Weight. The three traffic levels are as shown in Table 334-1.

Table 334-1 Superpave Traffic Levels		
Traffic Level	Traffic Level ($1x10^6$ ESAL's)	Aircraft Gross Weight, Pounds
A	<0.3	<12,500
B	0.3 to <3	12,500 to <60,000
C	3 to <10	12,500 to <60,000

The traffic level(s) for the project are as specified in the Contract. A Type SP mix one traffic level higher than the traffic level specified in the Contract may be substituted, at no cost to the Airport Owner (i.e. Traffic Level B may be substituted for Traffic Level A, etc.).

Delete Subsection 334-2.2 and substitute the following:

334-2.2: Superpave Asphalt Binder: Unless specified otherwise in the Contract, use a PG 67-22 asphalt binder for Traffic Level A and a PG 76-22 for Traffic Level B and C. In addition, meet the requirements of 334-2.3.

Delete Subsection 334-2.3.1, Sub-Subsection 1. and substitute the following:

1. For Traffic Level A, B, and C mixtures, limit the amount of RAP material used to 15% of the weight of total aggregate for surface courses and 25% of the weight of total aggregate for base, leveling, and shoulder courses for PG XX-16 without change in binder selection.
2. For Traffic Level A, B, and C mixtures, limit the amount of RAP material used to 20% of the weight of total aggregate for surface courses and 25% of the weight of total aggregate for base, leveling, and shoulder courses for PG XX-22, or lower, select virgin binder one grade softer than normal.
3. For additional details, and for PG XX-10, or higher, reference Final Report, AAPTP 05-06, Use of Reclaimed Asphalt Pavements (RAP) in HMA Airfield Pavements, July, 2008.

Delete Subsection 334-3.2.2 and 334-3.2.2.1 and substitute the following:

334-3.2.2 Mixture Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this specification and conform to the gradation requirements at design as defined in AASHTO M323-04, Table 334-3, with the following exception: 4.74 mm aggregate gradation shall not be used for airport pavement. Aggregates from various sources may be combined.

334-3.2.2.1 Mixture Gradation Classification. Plot the combined mixture gradation on an FHWA 0.45 Power Gradation Chart. Include the Control Points from AASHTO M323-04, Table-3, as well as the Primary Control Sieve (PCS) Control Point from AASHTO M323-04, Table 4. Coarse mixes are defined as having a combined aggregate gradation that passes below the primary control sieve control point, and fine mixes are defined as having a gradation that passes above or through the primary control sieve control point. Use only a fine mix for traffic levels A through C.

Delete Subsection 334-4 and substitute the following:

334-4 Contractor Process Control.

334-4.1 General: Assume full responsibility for controlling all operations and processes such that the requirements of these Specifications are met at all times. Perform any tests necessary at the plant and roadway for process control purposes. The Engineer will not use these test results in the acceptance payment decision.

Address in the Quality Control Plan how Process Control failures will be handled. Investigate, at a minimum, the production process, testing equipment and/or sampling methods to determine the cause of the failure, and make any necessary changes to assure compliance with these Specifications. Obtain a follow up sample immediately after corrective actions are taken to assess the adequacy of the corrections. In the event the follow-up Process Control sample also fails to meet Specification requirements, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Engineer.

334-4.2 Testing Laboratory: The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. It shall be available for joint use by the Contractor for quality control testing and by the Engineer for acceptance testing and must have adequate equipment for the performance of the tests required by these specifications. The Engineer shall have priority in use of the equipment necessary for acceptance testing.

The effective working area of the laboratory shall be a minimum of 150 square feet (14 square meters) with a ceiling height of not less than 7.5 feet (2.3 meters). Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70 degrees F + 5 degrees (21 degrees C + 2.3 degrees C).

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

Delete Subsection 334-5.1.1, 334-5.1.1.1, and 334-5.1.2 and substitute the following:

334-5.1.1 General: The mixture will be accepted at the plant with respect to gradation (P_{-8} and P_{-200}), asphalt content (P_b), and volumetrics (volumetrics is defined as air voids at N_{design}). The mixture will be accepted on the roadway with respect to density of roadway cores for mat and joint. Roadway cores, hereinafter, shall refer to both mat and joint cores in equivalent number of cores for joint as specified for mat in later subsections of the specification. Acceptance will be on a LOT-by-LOT basis (for each mix design) based on tests of random samples obtained within each sublot taken at a frequency of one set of samples per sublot. A roadway LOT and a plant production LOT shall be the same. All acceptance testing necessary to determine conformance with the acceptance requirements will be performed by the Engineer at no cost to the Contractor. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be calibrated by the testing organization prior to the start of operations. All Contractor personnel preparing laboratory compacted acceptance specimens shall be a state certified Superpave Field Testing Technician or equivalent acceptable to the Engineer.

334-5.1.1.1 Sampling and Testing Requirements: Obtain the samples in accordance with FM 1-T 168. Obtain samples at the plant of a sufficient quantity to be split into three smaller samples; one for Quality Control, one for Verification, and one for Resolution testing; each sample at approximately 35 pounds. The split samples for Verifications testing shall be provided to the Engineer. The split samples for Resolution testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12” x 8” x 4”. Label and safely store these boxes in a manner agreed upon by the Engineer for future testing. The Contractor can retain additional split samples at their option. From this subsection forward, sampling and testing shall be as specified with the exception that the Verification samples will be tested by the Engineer for each sublot. At the completion of each lot, in the manner specified for plant and roadway testing in the following subsections, the individual Verification test results will be compared with the individual Quality Control test results by the Engineer based on the between-laboratory precision values provided in this specification. Procedures for acceptance and/or Resolution testing will comply with procedures outlined by this specification, except as modified above, wherein the role of the Verification and Quality Control split sample testing has been reversed to accommodate acceptance of the mixture and completed pavement by the Engineer Verification split samples compared to the Contractor Quality Control split samples.

The asphalt content of the mixture will be determined in accordance with FM 5-563. In the event the FM 5-563 ignition oven goes out of service during production, the Contractor may elect to use a replacement oven at another location for no more than 72 hours while the oven is being repaired. The gradation of the recovered aggregate will be determined in accordance with FM 1-T 030. Volumetric testing will be in accordance with AASHTO T312-04 and FM 1-T 209. Prior to testing volumetric samples, condition the test-sized sample for one hour at the target roadway compaction temperature in a covered, shallow, flat pan. Test for roadway density in accordance with FM 1-T 166. Roadway joints will not be tested when two or less sublot test results are available for a lot.

334-5.1.2 Acceptance Testing Exceptions: Unchanged, except delete the sentence “In addition, density testing for acceptance will not be performed on the following areas when they are less than 1,000 feet in length: crossovers, intersections, turning lanes, acceleration lanes, deceleration lanes, shoulders, or ramps.”

Delete Table 334-7, Subsection 334-8.2.2.2 and substitute the following:

Table 334-7
Specification Limits

Quality Characteristic	Specification Limits
Passing No. 8 sieve (percent)	Target ± 3.1
Passing No. 200 sieve (percent)	Target ± 1.0
Asphalt Content (percent)	Target ± 0.40
Air Voids - Coarse Mixes (percent)	4.00 ± 1.40
Air Voids - Fine Mixes (percent)	4.00 ± 1.20
Mat Density - Coarse Mixes (percent of G_{mm}):	94.50 ± 1.30
Joint Density - Coarse Mixes (percent of G_{mm}):	93.00 ± 1.30
Mat Density - Fine Mixes (percent of G_{mm}):	93.00 + 2.00, - 1.20 (1)

Table 334-7 **Specification Limits**	
Quality Characteristic	Specification Limits
Joint Density - Fine Mixes (percent of G_{mm}):	91.50 + 2.00, - 1.20 (1)
Note (1): If the Engineer (or Contract Documents) limits compaction to the static mode only, the specification limits are as follows: 92.00 + 3.00, -1.20. No additional compensation, cost or time, shall be made.	

Insert Subsection 334-5.4.5 and 334-5.4.6 as follows:

334-5.4.5 Smoothness: The final surface shall be free from roller marks. The finished surfaces of each course of the pavement, except the finished surface of the final course, shall not vary more than ⅜ inch when evaluated with a 16 foot straightedge. The finished surface of the final course of pavement shall not vary more than ¼ inch when evaluated with a 16 foot straightedge. The lot size shall be 2,000 square yards. Smoothness measurements shall be made at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made at the center of each paving lane. In the transverse direction, smoothness readings shall be made continuously across the full width of the pavement. However, transverse smoothness readings shall not be made across designed grade changes. At warped transition areas, straightedge position shall be adjusted to measure surface smoothness and not design grade transitions. When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.

334-5.4.6 Grade: The finished surface of the pavement shall not vary from the grade line elevations and cross sections shown on the plans by more than ½ inch (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet) to determine the elevation of the completed pavement. The Contractor shall pay the cost of surveying of the level runs that shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer. The lot size shall be 2,000 square yards (square meters). When more than 15 percent of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates ¾ inch or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. The surface of the ground pavement shall have a texture consisting of grooves between 0.090 and 0.130 inches wide. The peaks and ridges shall be approximately 1/32 inch higher than the bottom of the grooves. The pavement shall be left in a clean condition. The removal of all of the slurry resulting form the grinding operation shall be continuous The grinding operation should be controlled so the residue from the operation does not flow across other lanes of pavement. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.

334-5.4.7 Skid Resistance Surfaces/Saw-Cut Grooves: If shown on the plans, skid resistant surfaces for HMA pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving. Transverse grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1-½ inches center to center configuration. The grooves shall be continuous for the entire length of the groove. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for saw-cut grooves shall meet the following:

- **Alignment tolerance –** Plus or minus 1-½ inches in alignment for 75 feet.

- **Groove tolerance –** Minimum depth 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch. Maximum depth 5/16 inch. Minimum width ¼ inches. Maximum width 5/16 inch.

- **Center-to-center spacing –** Minimum spacing 1-3/8 inches. Maximum spacing 1-5/8 inches.

Grooves shall not be less than 6.0 inches and not more than 18.0 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with governing laws and regulations. All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

Delete Subsection 334-8.3 and substitute the following:

334-8.3 Composite Pay Factor (CPF). A Composite Pay Factor for the LOT will be calculated based on the individual Pay Factors (PF) with the following weighting applied: 30 percent Mat Density (D_m), 15 percent Joint Density (D_j), 20 percent Air Voids (V_a), 20 percent asphalt binder content (P_b), 10 percent Passing No. 200 (P_{-200}) and 5 percent Passing No. 8 (P_{-8}). Calculate the CPF by using the following formula:

$$CPF = [(0.300 \text{ x PF } D_m) + (0.150 \text{ x PF } D_j) + (0.200 \text{ x PF } V_a) + (0.200 \text{ x PF } P_b) + (0.100 \text{ x PF } P_{-200}) + (0.050 \text{ x PF } P_{-8})]$$

Where the Pay Factor (PF) for each quality characteristic is determined in either 334-8.2.1 or 334-8.2.2, depending on the number of sublot tests. Note that the number after each multiplication will be rounded to the nearest 0.01.

The pay adjustment shall be computed by multiplying the Composite Pay Factor for the LOT by the bid price per ton.

Insert Subsection 334-8.3.1 as follows:

334-8.3.1 Total Project Payment. The total project payment for HMA pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons of HMA mixture used in the accepted work. Payment in excess of 100 percent for accepted lots of HMA pavement shall be used to offset payment for accepted lots of HMA pavement that achieve a lot pay factor less than 100 percent. The calculation of excess and offset shall be applied as equivalent amounts. In the event a lot is identified for removal and replacement in accordance with criteria specified in the SSHP specifications, or as specified in other sections referenced in the SSSM, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and the Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price AND THE TOTAL PROJECT PAYMENT LIMITATION SHALL BE REDUCED BY THE AMOUNT WITHHELD FOR THE REJECTED LOT.

APPENDIX A2

FDOT Section 334

Superpave Asphalt Concrete

SECTION 334
SUPERPAVE ASPHALT CONCRETE

334-1 Description.

334-1.1 General: Construct a Superpave Asphalt Concrete pavement with the type of mixture specified in the Contract, or when offered as alternates, as selected. Superpave mixes are identified as Type SP-9.5, Type SP-12.5 or Type SP-19.0.

Meet the requirements of Section 320 for plant and equipment. Meet the general construction requirements of Section 330, including the provision for Quality Control Plans and Quality Control Systems as specified in 6-8.

The Engineer will accept the work on a LOT-to-LOT basis in accordance with the applicable requirements of this Specification. The size of the LOT will be as specified in 334-5.2.

334-1.2 Traffic Levels: The requirements for Type SP Asphalt Concrete mixtures are based on the design traffic level of the project, expressed in 18,000 pound Equivalent Single Axle Loads (ESAL's). The five traffic levels are as shown in Table 334-1.

Table 334-1
Superpave Traffic Levels

Traffic Level	Traffic Level ($1x10^6$ ESAL's)
A	<0.3
B	0.3 to <3
C	3 to <10
D	10 to <30
E	≥30

The traffic level(s) for the project are as specified in the Contract. A Type SP mix one traffic level higher than the traffic level specified in the Contract may be substituted, at no cost to the Department (i.e. Traffic Level B may be substituted for Traffic Level A, etc.).

334-1.3 Gradation Classification: The Superpave mixes are classified as either coarse or fine, depending on the overall gradation of the mixture. Coarse and fine mixes are defined in 334-3.2.2.

The equivalent AASHTO nominal maximum aggregate size Superpave mixes are as follows:

Type SP-9.5 .... 9.5 mm
Type SP-12.5 .... 12.5 mm
Type SP-19.0 .... 19.0 mm

334-1.4 Thickness: The total thickness of the Type SP asphalt layer(s) will be the plan thickness as shown in the Contract documents. Before paving, propose a thickness for each individual layer meeting the requirements of this specification, which when combined with other layers (as applicable) will equal the plan thickness. For construction purposes, the plan thickness and individual layer thickness will be converted to spread rate based on the maximum specific gravity of the asphalt mix being used, as well as the minimum density level, as shown in the following equation:

Spread rate (lbs/yd^2) $= t \times G_{mm} \times 43.3$

Where: t = Thickness (in.) (Plan thickness or individual layer thickness)
G_{mm} = Maximum specific gravity from the verified mix design

The weight of the mixture shall be determined as provided in 320-2.2. For target purposes only, spread rate calculations should be rounded to the nearest whole number.

Note: Plan quantities are based on a G_{mm} of 2.540, corresponding to a spread rate of 110 lbs/yd^2-in. Pay quantities will be based on the actual maximum specific gravity of the mix being used.

334-1.4.1 Layer Thicknesses - Fine Mixes: The allowable layer thicknesses for fine Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 .... 1 - 1 1/2 inches
Type SP-12.5 .... 1 1/2 - 2 1/2 inches
Type SP-19.0 .... 2 - 3 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on fine mixes when used as a structural course:

Type SP-9.5 - Limited to the top two structural layers, two layers maximum.
Type SP-9.5 – May not be used on Traffic Level D and E applications.
Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.4.2 Layer Thicknesses - Coarse Mixes: The allowable layer thicknesses for coarse Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 .... 1 1/2 - 2 inches
Type SP-12.5 .... 2 - 3 inches
Type SP-19.0 .... 3 - 3 1/2 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on coarse mixes when used as a structural course:

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.4.3 Additional Requirements: The following requirements also apply to coarse and fine Type SP Asphalt Concrete mixtures:

1. A minimum 1 1/2 inch initial lift is required over an Asphalt Rubber Membrane Interlayer (ARMI).

2. When construction includes the paving of adjacent shoulders (≤5 feet wide), the layer thickness for the upper pavement layer and shoulder must be the same and paved in a single pass, unless called for differently in the Contract documents.

3. All overbuild layers must be fine Type SP Asphalt Concrete designed at the traffic level as stated in the Contract. Use the minimum and maximum layer thicknesses as specified above unless called for differently in the Contract documents. On variable thickness overbuild layers, the minimum allowable thickness may be reduced by 1/2 inch, and the maximum allowable thickness may be increased 1/2 inch, unless called for differently in the Contract documents.

334-2 Materials.

334-2.1 General Requirements: Meet the material requirements specified in Division III. Specific references are as follows:

Superpave PG Asphalt Binder or Recycling Agent
.... 916-1, 916-2
Coarse Aggregate ....Section 901
Fine Aggregate ....Section 902

334-2.2 Superpave Asphalt Binder: Unless specified otherwise in the Contract, use a PG 67-22 asphalt binder with the following exceptions: for Traffic Level D, use a PG 76-22 asphalt binder in the final structural layer; for Traffic Level E, use a PG 76-22 asphalt binder in the top two structural layers. In addition, meet the requirements of 334-2.3.

334-2.3 Reclaimed Asphalt Pavement (RAP) Material:

334-2.3.1 General requirements: RAP may be used as a component of the asphalt mixture subject to the following requirements:

1. For Traffic Levels A, B and C mixtures, limit the amount of RAP material used in the mix to a maximum of 50 percent by weight of total aggregate. For Traffic Levels D and E mixtures, limit the amount of RAP material used in the mix to a maximum of 30 percent by weight of total aggregate.

2. When using a PG 76-22 Asphalt Binder, limit the amount of RAP material used in the mix to a maximum of 15 percent by weight of total aggregate.

3. Assume full responsibility for the design, production and construction of asphalt mixes which incorporate RAP as a component material.

4. Use RAP from an FDOT approved stockpile or RAP that has an FDOT furnished Pavement Composition Data Sheet.

5. Do not use RAP material in any friction course mixes.

6. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

7. Provide RAP material having a minimum average asphalt content of 4.0 percent by weight of total mix. The Engineer may sample the stockpile to verify that this requirement is met.

334-2.3.2 Material Characterization: Assume responsibility for establishing the asphalt binder content, gradation, viscosity and bulk specific gravity (G_{sb}) of the RAP material based on a representative sampling of the material. Obtain the samples by one of the following methods:

1. Roadway cores: Cut a minimum number of cores to be representative of the pavement prior to milling. Fill the core holes prior to opening to traffic. Assume responsibility for accounting for the degradation that will occur during the milling operation.

2. Milling: Obtain representative samples by milling the existing pavement to the full depth shown on the plans for a minimum length of approximately 200 feet. If required to maintain traffic, immediately replace the pavement removed with the mix specified in the Contract. This mix will be paid for at the Contract unit price.

3. Stockpile sampling: Obtain samples from a stockpile of either milled or processed RAP. Take representative samples at random locations around the stockpile. Request the Engineer to make a visual inspection of the stockpiled RAP material. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled materials. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.

Determine the binder content and gradation of the RAP material in accordance with FM 5-563 and FM 1-T 030, respectively. Extract and recover the asphalt binder from the RAP in accordance with FM 5-524 and FM 3-D 5404, respectively. Determine the viscosity of the recovered asphalt binder in accordance with ASTM D2171. Establish the G_{sb} of the RAP material by using one of the following methods:

a) Calculate the G_{sb} value based upon the effective specific gravity (G_{se}) of the RAP material, determined on the basis of the asphalt binder content and maximum specific gravity (G_{mm}) of the RAP material. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b) Measure the G_{sb} of the RAP aggregate, in accordance with FM 1-T 084 and FM 1-T 085. Obtain the aggregate by using either a solvent or ignition oven extraction method.

334-2.3.3 Pavement Composition: When the Contract includes milling of the existing asphalt pavement, the Pavement Composition Data Sheet may be available on the Department's website. The URL for obtaining this information, if available, is:
http://www.dot.state.fl.us/statematerialsoffice/laboratory/asphalt/centrallaboratory/compositions/index.htm

334-2.3.4 Asphalt Binder for Mixes with RAP: Select the appropriate asphalt binder grade based on Table 334-2. The Engineer reserves the right to change the asphalt binder type and grade at design based on the characteristics of the RAP asphalt binder, and reserves the right to make changes during production. Maintain the viscosity of the recycled mixture within the range of 4,000 to 12,000 poises. Obtain a sample of the mixture for the Engineer within the first 1,000 tons of production and at a continuing frequency of one sample per 4,000 tons of mix.

Table 334-2
Asphalt Binder Grade for Mixes Containing RAP

Percent RAP	Asphalt Binder Grade
<20	PG 67-22
20 – 29	PG 64-22
≥ 30	Recycling Agent

334-2.4 Recycled Crushed Glass: Recycled crushed glass may be used as a component of the asphalt mixture subject to the following requirements:

1. Consider the recycled crushed glass a local material and meet all requirements specified in 902-6.
2. Limit the amount of recycled crushed glass to a maximum of 15 percent by weight of total aggregate.
3. Use an asphalt binder that contains a minimum of 0.5 percent anti-stripping agent by weight of binder. The antistrip additive shall be one of the products included on the Qualified Products List specified in 6-1 of the Specifications. The antistrip additive shall be introduced into the asphalt binder by the supplier during loading.
4. Do not use recycled crushed glass in friction course mixtures or in structural course mixtures which are to be used as the final wearing surface.

334-3 General Composition of Mixture.

334-3.1 General: Compose the asphalt mixture using a combination of aggregate (coarse, fine or mixtures thereof), mineral filler, if required, and asphalt binder material. Size, grade and combine the aggregate fractions to meet the grading and physical properties of the mix design. Aggregates from various sources may be combined.

334-3.2 Mix Design:

334-3.2.1 General: Design the asphalt mixture in accordance with AASHTO R35-04, except as noted herein. Prior to the production of any asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all mix design criteria to the Engineer. Include representative samples of all component materials, including asphalt binder. Allow the State Materials Engineer a maximum of four weeks to either conditionally verify or reject the mix as designed. Final verification of the mix design will occur when the requirements of 334-5.2.1 have been met. Do not use more than three mix designs per nominal maximum aggregate size per traffic level per binder grade per contract year. Exceeding this limitation will result in a maximum Composite Pay Factor of 1.00 as defined in 334-8.2 for all designs used beyond this limit.

The Engineer will consider any marked variations from original test data for a mix design or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of the mix design.

334-3.2.2 Mixture Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this specification and conform to the gradation requirements at design as defined in AASHTO M323-04, Table 3. Aggregates from various sources may be combined.

334-3.2.2.1 Mixture Gradation Classification: Plot the combined mixture gradation on an FHWA 0.45 Power Gradation Chart. Include the Control Points from AASHTO M323-04, Table-3, as well as the Primary Control Sieve (PCS) Control Point from AASHTO M323-04, Table 4. Coarse mixes are defined as having a combined aggregate gradation that passes below the primary control sieve control point, and fine mixes are defined as having a gradation that passes above or through the primary control sieve control point. Use either a coarse mix or fine mix for Traffic Levels A - E.

334-3.2.3 Aggregate Consensus Properties: Meet the following consensus properties at design for the aggregate blend:

334-3.2.3.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D 5821, meet the percentage of fractured faces requirements specified in AASHTO M323-04, Table 5.

334-3.2.3.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T-304, Method A, meet the uncompacted void content of fine aggregate specified in AASHTO M323-04, Table 5.

334-3.2.3.3 Flat and Elongated Particles: When tested in accordance with ASTM D 4791, (with the exception that the material passing the 3/8 inch sieve and retained on the No. 4 sieve shall be included), meet the requirements specified in AASHTO M323-04, Table 5. Measure the aggregate using the ratio of 5:1, comparing the length (longest dimension) to the thickness (shortest dimension) of the aggregate particles.

334-3.2.3.4 Sand Equivalent: When tested in accordance with AASHTO T 176, meet the sand equivalent requirements specified in AASHTO M323-04, Table 5.

334-3.2.4 Gyratory Compaction: Compact the design mixture in accordance with AASHTO T312-04. Use the number of gyrations as defined in AASHTO R35-04, Table 1 with the following exceptions: for Traffic Level C mixes, compact the mixture as specified for the Traffic Level of 0.3×10^6 to $< 3 \times 10^6$ ESAL's; for Traffic Level E mixes, compact the mixture as specified for 10×10^6 to $< 30 \times 10^6$ ESAL's.

334-3.2.5 Design Criteria: Meet the requirements for nominal maximum aggregate size as defined in AASHTO M323-04, as well as for relative density, VMA, VFA, and dust-to-binder ratio as specified in AASHTO M323-04, Table 6. Use a dust-to-binder ratio of 0.8 to 1.6 for coarse mixes.

334-3.2.6 Moisture Susceptibility: Test 4 inch specimens in accordance with FM 1-T 283. Provide a mixture having a retained tensile strength ratio of at least 0.80 and a minimum tensile strength (unconditioned) of 100 psi. If necessary, add a liquid anti-stripping agent, which is on the Department's Qualified Products List or hydrated lime (meeting the requirements of 337-10.2) in order to meet these criteria.

334-3.2.7 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The design traffic level and the design number of gyrations (N_{design}).
2. The source and description of the materials to be used.
3. The DOT source number and the DOT product code of the aggregate components furnished from a DOT approved source.
4. The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation caused by handling and processing as necessary.

5. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly material passing the No. 200 sieve) should be accounted for and identified.

6. The bulk specific gravity (G_{sb}) value for each individual aggregate and RAP component, as identified in the Department's aggregate control program.

7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1 percent.

8. A target temperature at which the mixture is to be discharged from the plant and a target roadway temperature (per 330-6.3). Do not exceed a target temperature of 330°F for modified asphalts and 315°F for unmodified asphalts.

9. Provide the physical properties achieved at four different asphalt binder contents. One of which shall be at the optimum asphalt content, and must conform to all specified physical requirements.

10. The name of the CTQP Qualified Mix Designer.

11. The ignition oven calibration factor.

334-3.3 Mix Design Revisions: During production, the Contractor may request a target value revision to a mix design, subject to meeting the following requirements: (1) the target change falls within the limits defined in Table 334-3, (2) appropriate data exists demonstrating that the mix complies with production air voids specification criteria, and (3) the mixture gradation meets the basic gradation requirements defined in 334-3.2.2.

Table 334-3
Limits for Potential Adjustments to Mix Design Target Values

Characteristic	Limit from Original Mix Design
No. 8 sieve and Coarser	± 5.0 percent
No. 16 sieve	± 4.0 percent
No. 30 sieve	± 4.0 percent
No. 50 sieve	± 3.0 percent
No. 100 sieve	± 3.0 percent
No. 200 sieve	± 1.0 percent
Asphalt Binder Content (1)	± 0.3 percent

(1) Reductions to the asphalt binder content will not be permitted if the VMA during production is lower than 1.0 percent below the design criteria.

Submit all requests for revisions to mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until the Engineer authorizes a change. In no case will the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required if aggregate sources change, or for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

334-4 Contractor Process Control.

Assume full responsibility for controlling all operations and processes such that the requirements of these Specifications are met at all times. Perform any tests necessary at the plant and roadway for process control purposes. The Engineer will not use these test results in the acceptance payment decision.

Address in the Quality Control Plan how Process Control failures will be handled. Investigate, at a minimum, the production process, testing equipment and/or sampling methods to determine the cause of the failure, and make any necessary changes to assure compliance with these Specifications. Obtain a follow up sample immediately after corrective actions are taken to assess the adequacy of the corrections. In the event the follow-up Process Control sample also fails to meet Specification requirements, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Engineer.

334-5 Acceptance of the Mixture.

334-5.1 General: The mixture will be accepted at the plant with respect to gradation (P_{-8} and P_{-200}), asphalt content (P_b), and volumetrics (volumetrics is defined as air voids at N_{design}). The mixture will be accepted on the roadway with respect to density of roadway cores. Acceptance will be on a LOT-by-LOT basis (for each mix design) based on tests of random samples obtained within each sublot taken at a frequency of one set of samples per sublot. A roadway LOT and a plant production LOT shall be the same. Acceptance of the mixture will be based on Contractor Quality Control test results that have been verified by the Department.

334-5.1.1 Sampling and Testing Requirements: Obtain the samples in accordance with FM 1-T 168. Obtain samples at the plant of a sufficient quantity to be split into three smaller samples; one for Quality Control, one for Verification and one for Resolution testing; each sample at approximately 35 pounds. The split samples for Verification testing and Resolution testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12” x 8” x 4”. Label and safely store these boxes in a manner agreed upon by the Engineer for future testing. The Contractor can retain additional split samples at their option.

The asphalt content of the mixture will be determined in accordance with FM 5-563. In the event the FM 5-563 ignition oven goes out of service during production, the Contractor may elect to use a replacement oven at another location for no more than 72 hours while the oven is being repaired. The gradation of the recovered aggregate will be determined in accordance with FM 1-T 030. Volumetric testing will be in accordance with AASHTO T312-04 and FM 1-T 209. Prior to testing volumetric samples, condition the test-sized sample for one hour at the target roadway compaction temperature in a covered, shallow, flat pan. Test for roadway density in accordance with FM 1-T 166.

334-5.1.2 Acceptance Testing Exceptions: When the total quantity of any mix type in the Project is less than 500 tons, the Engineer will accept the mix on the basis of visual inspection. The Engineer may require the Contractor to run process control tests for informational purposes, as defined in 334-4, or may run independent verification tests to determine the acceptability of the material.

Density testing for acceptance will not be performed on widening strips or shoulders with a width of 5 feet or less, open-graded friction courses, variable thickness overbuild courses, leveling courses, first lift of asphalt base course placed on subgrade, miscellaneous asphalt pavement, or any course with a specified thickness less than 1 inch or a specified spread rate that converts to less than 1 inch as described in 334-1.4. In addition, density testing for acceptance will not be performed on the following areas when they are less than 1,000 feet in length: crossovers, intersections, turning lanes, acceleration lanes, deceleration lanes, or ramps. Compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure (equipment and pattern) submitted as part of the Quality Control Plan and as approved by the Engineer. In the event that the rolling procedure deviates from the approved procedure, placement of the mix shall be stopped.

The density pay factor (as defined in 334-8.2) for LOTs where there are areas not requiring density testing for acceptance will be prorated based on a pay factor of 1.00 for the quantity (tonnage) of material in areas not requiring density testing for acceptance and the actual pay factor for the tonnage of material in areas requiring density.

334-5.2 LOT Sizes: LOT sizes will be either 2,000 tons or 4,000 tons. The Initial Production LOT of all mix designs used on a project shall consist of 2,000 tons, subdivided into four equal sublots of 500 tons each. Following the Initial Production LOT, each remaining LOT will be defined (as selected by the Contractor prior to the start of the LOT) as either (1) 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each, or (2) 4,000 tons (as authorized by the Engineer per 334-5.2.1), with each LOT subdivided into four equal sublots of 1,000 tons each. Before the beginning of a LOT, the Engineer will develop a random sampling plan for each sublot and direct the Contractor on sample points, based on tonnage, for each sublot during construction.

In the event a LOT is terminated per 334-5.4.4, the LOT size upon resuming production of the mixture will be 2000 tons until the requirements of 334-5.2.1 are met.

334-5.2.1 Criteria for 4,000 ton LOTs: At the completion of the Initial Production LOT, the quality of the as-produced material will be evaluated by the Engineer. Begin the option of 4,000 ton LOT sizes only when authorized by the Engineer based upon the Quality Control test results for the Initial Production LOT meeting the following:

1. A minimum Pay Factor of 0.90 for each asphalt quality characteristic as defined in 334-8.2.

2. A favorable comparison with the Verification test results. Comparisons between the Quality Control and Verification test results will be based on between-laboratory precision values shown in Table 334-5.

3. A coefficient of permeability of less than 125 x 10^{-5}cm/s on each roadway core as determined in accordance with FM 5-565. Permeability criteria apply only to coarse mixes when the average density for the sublot is less than 93.00 percent of G_{mm}, or when an individual density value is less than 91.00 percent of G_{mm}.

In the event that the Initial Production LOT does not meet these criteria, limit production LOT sizes to 2,000 tons with 500 ton sublots until these criteria are met.

334-5.2.2 Partial LOTs: A partial LOT is defined as a LOT size that is less than a full LOT. A partial LOT may occur due to the following:

l. The completion of a given mix type or mix design on a project.

2. A LOT termination due to a 60 day or greater delay in production.
(Time periods other than 60 days may be used if agreed to by both Engineer and Contractor.)

3. A LOT is terminated per 334-5.4.4.

All partial LOTs will be evaluated based on the number of tests available, and will not be redefined.

334-5.3 Initial Production Requirements: The Initial Production LOT of all mix designs shall be established at 2,000 tons. During this period demonstrate the capability to produce and place the mixture as specified unless waived by the Engineer in 334-3.2.1. If necessary, during this time, make adjustments to the mix design, as defined in 334-3.3. Any target value adjustments to the mix design will result in the LOT being terminated and evaluated for payment purposes per 334-8. Do not begin 4,000 ton LOT sizes until a 2,000 ton initial production LOT (for each mix design) has been successfully completed, or is waived by the Engineer.

At the sole option of the Engineer, the requirement for an Initial Production LOT may be waived based on evidence of satisfactory production, placement and performance on previous projects for that particular mix.

334-5.3.1 Plant Sampling and Testing Requirements: Obtain one random sample of mix per sublot in accordance with 334-5.1.1 as directed by the Engineer. Test the Quality Control split sample for gradation, asphalt binder content and volumetrics in accordance with 334-5.1.1. Complete all Quality Control testing within one working day from the time the samples were obtained.

334-5.3.2 Roadway Sampling and Testing Requirements: Obtain five 6 inch diameter roadway cores within 24 hours of placement at random locations as directed by the Engineer within each sublot. Test these Quality Control samples for density in accordance with 334-5.1.1.

The G_{mm} used for the density evaluation will be based on the Quality Control test result for the corresponding sublot.

On coarse mixes when the average density for an Initial Production sublot is less than 93.00 percent of G_{mm}, or an individual core density is less than 91.00 percent of G_{mm}, cut five 6 inch diameter roadway cores (at locations determined by the Engineer) and have them evaluated for permeability in accordance with FM 5-565 by a laboratory as approved by the Engineer. If approved by the Engineer, the original cores cut for density testing purposes may be used to evaluate permeability.

334-5.3.3 Verification of Initial Production LOT: For Verification purposes the Engineer will test a minimum of one split sample as described in 334-5.1.1 from the Initial Production LOT at the completion of the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from when the LOT is completed.

The Verification test results will be compared with the corresponding Quality Control test results based on the between-laboratory precision values shown in Table 334-5.

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Quality Control results for the LOT.

If any of the results do not compare favorably, then the split Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.6.

334-5.3.4 Acceptance of Initial Production LOT: The Initial Production LOT shall be considered a single LOT and will receive a Composite Pay Factor as determined in 334-8, based on results of the verified Quality Control tests, or as determined by the Resolution System.

334-5.4 Quality Control Sampling and Testing: Obtain all samples randomly as directed by the Engineer.

Should the Engineer determine that the Quality Control requirements are not being met or that unsatisfactory results are being obtained, or should any instances of falsification of test data occur, approval of the Contractor's Quality Control Plan will be suspended and production will be stopped.

334-5.4.1 Lost or Missing Verification/Resolution Samples: In the event that any of the Verification and/or Resolution samples that are in the custody of the Contractor are lost, damaged, destroyed, or are otherwise unavailable for testing, the minimum possible pay factor for each quality characteristic as described in 334-8.2 will be applied to the entire LOT in question, unless called for otherwise by the Engineer. Specifically, if the LOT in question has more than two sublots, the pay factor for each quality characteristic will be 0.55. If the LOT has two or less sublots, the pay factor for each quality characteristic will be 0.80. In either event, the material in question will also be evaluated in accordance with 334-5.9.5.

If any of the Verification and/or Resolution samples that are in the custody of the Department are lost, damaged, destroyed or are otherwise unavailable for testing, the corresponding Quality Control test result will be considered verified, and payment will be based upon the Contractor's data.

334-5.4.2 Plant Sampling and Testing Requirements: Obtain one random sample of mix per sublot in accordance with 334-5.1.1 as directed by the Engineer. Test the Quality Control split sample for gradation, asphalt binder content and volumetrics in accordance with 334-5.1.1. Complete all Quality Control testing within one working day from the time the samples were obtained.

334-5.4.3 Roadway Sampling and Testing Requirements: Obtain five 6 inch diameter roadway cores within 24 hours of placement at random locations as directed by the Engineer within each sublot. Test these Quality Control samples for density (G_{mb}) in accordance with 334-5.1.1. In situations where it is impractical to cut five cores per sublot, obtain a minimum of three cores per sublot at random locations as identified by the Engineer. Do not obtain cores any closer than 12 inches from an unsupported edge. Maintain traffic during the coring operation; core the roadway, patch the core holes (within three days of coring); and trim the cores to the proper thickness prior to density testing.

Density for the sublot shall be based on the average value for the cores cut from the sublot with the target density being the maximum specific gravity (G_{mm}) of the sublot. Once the average density of a sublot has been determined, do not retest the samples unless approved by the Engineer. Ensure proper handling and storage of all cores until the LOT in question has been accepted.

334-5.4.4 Individual Test Tolerances for Quality Control Testing: In the event that an individual Quality Control test result of a sublot for air voids, or the average sublot density for coarse graded mixes does not meet the requirements of Table 334-4, terminate the LOT and stop production of the mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test result in accordance with 334-5.9.5.

In the event that an individual Quality Control test result of a sublot for gradation (P_{-8} or P_{-200}), asphalt binder content, or the average sublot density for fine graded mixes does not meet the requirements of Table 334-4, or an individual core density is less than 91.00 percent of G_{mm} (for coarse mixes), take steps to correct the situation and report the actions to the Engineer.

In the event that two consecutive individual Quality Control test results (for the same material characteristic) for gradation (P_{-8} and P_{-200}), asphalt binder content, or the average sublot density for fine graded mixes do not meet the requirements of Table 334-4, or two individual core densities within a sublot are less than 91.00 percent of G_{mm} (for coarse mixes), terminate the LOT and stop production of the mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test result in accordance with 334-5.9.5.

Any LOT terminated under this subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for each quality characteristic.

Table 334-4
Master Production Range

Characteristic	Tolerance (1)
Asphalt Binder Content (percent)	Target ±0.55
Passing No. 8 Sieve (percent)	Target ±5.50
Passing No. 200 Sieve (percent)	Target ±1.50
Air Voids (percent) Coarse Graded	2.00 - 6.00
Air Voids (percent) Fine Graded	2.30 - 6.00
Density, percent G_{mm} (2)	
Coarse Graded (minimum)	93.00
Fine Graded (minimum)	90.00

(1) Tolerances for sample size of n = 1 from the verified mix design
(2) Based on an average of 5 randomly located cores

334-5.5 Verification Testing: In order to determine the validity of the Contractor’s Quality Control test results prior to their use in the Acceptance decision, the Engineer will run verification tests.

334-5.5.1 Plant Testing: At the completion of each LOT, the Engineer will test a minimum of one Verification split sample randomly selected from the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed. Verification samples shall be reheated at the target roadway compaction temperature for 1 1/2 hours, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.

The Verification test results will be compared with the Quality Control test results based on the between-laboratory precision values shown in Table 334-5.

Table 334-5 Between-Laboratory Precision Values	
Property	Maximum Difference
G_{mm}	0.016
G_{mb}	0.022
P_b	0.44 percent
P_{-200}	FM 1-T 030 (Figure 2)
P_{-8}	FM 1-T 030 (Figure 2)

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Contractor's Quality Control test data for the LOT.

If any of the results do not compare favorably, then the Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.6.

334-5.5.2 Roadway Testing: At the completion of each LOT, the Engineer will determine the density (G_{mb}) of each core (previously tested by Quality Control) as described in 334-5.1.1 from one randomly selected sublot from the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed.

The individual Verification test results will be compared with individual Quality Control test results by the Engineer based on the between-laboratory precision values given in Table 334-5 for G_{mb}.

If each of the core test results compare favorably, then the LOT will be accepted with respect to density, with payment based on the Contractor's Quality Control test data for the LOT.

If any of the results do not compare favorably, then the core samples from the LOT will be sent to the Resolution laboratory for testing as specified in 334-5.6.

334-5.6 Resolution System:

334-5.6.1 Plant Samples: In the event of an unfavorable comparison between the Contractor's Quality Control test results and the Engineer's Verification test results on any of the properties identified in Table 334-5, the Resolution laboratory will test all of the split samples from the LOT for only the property (or properties) in question. Resolution samples shall be reheated at the target roadway compaction temperature for 1 1/2 hours, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.

334-5.6.2 Roadway Samples: In the event of an unfavorable comparison between the Contractor's Quality Control test data and the Engineer's Verification test data on the density results, the Resolution laboratory will test all of the cores from the LOT. Testing will be as described in 334-5.1.1. Any damaged roadway cores will not be included in the evaluation; replace damaged cores with additional cores at the direction of the Engineer.

334-5.6.3 Resolution Determination: If the Resolution laboratory results compare favorably (for the property or properties in question) with all of the Quality Control results, then acceptance and payment for the LOT will be based on the Quality Control results, and the Department will bear the costs associated with Resolution testing. No additional compensation, either monetary or time, will be made for the impacts of any such testing.

If the Resolution laboratory results do not compare favorably (for the property or properties in question) with all of the Quality Control results, then acceptance and payment for the LOT will be based on the Resolution test data for the LOT, and the costs of the Resolution testing will be deducted from monthly estimates. No additional time will be granted for the impacts of any such testing.

In the event of an unfavorable comparison between the Resolution test results and Quality Control test results, make the necessary adjustments to assure that future comparisons are favorable.

334-5.7 Independent Verification Testing:

334-5.7.1 Plant: Take samples as directed by the Engineer for Independent Verification testing. The Contractor can retain split samples of these samples at their option. Independent Verification samples will be reheated at the target roadway compaction temperature for 1 1/2 hours, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. If any of the results do not meet the requirements of Table 334-4, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

334-5.7.2 Roadway: Obtain five roadway cores as directed by the Engineer for Independent Verification testing. These independent cores will be obtained from the same LOTs and sublots as the Independent Verification Plant samples, or as directed by the Engineer. The density of these cores will be obtained as described in 334-5.1.1. If the average of the results for the sublot does not meet the requirements of Table 334-4 for density, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

334-5.8 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 330-12.

334-5.9 Minimum Acceptable Quality Levels:

334-5.9.1 Pay Factors Below 0.90: In the event that an individual pay factor for any quality characteristic of a LOT falls below 0.90, take steps to correct the situation and report the actions to the Engineer. In the event that the pay factor for the same quality characteristic for two consecutive LOTs is below 0.90, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Actions taken must be approved by the Engineer before production resumes.

334-5.9.2 Composite Pay Factors Less Than 0.90 and Greater Than or Equal to 0.80: If the composite pay factor for the LOT is less than 0.90 and greater than or equal to 0.80, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Actions taken must be approved by the Engineer before production resumes.

334-5.9.3 Composite Pay Factors Less Than 0.80 and Greater Than or Equal to 0.75: If the composite pay factor for the LOT is less than 0.80 and greater than or equal to 0.75, address the defective material in accordance with 334-5.9.5.

334-5.9.4 Composite Pay Factors Less Than 0.75: If the composite pay factor for the LOT is less than 0.75, remove and replace the defective LOT at no cost to the Department, or as approved by the Engineer.

334-5.9.5 Defective Material: Assume responsibility for removing and replacing all defective material placed on the project, at no cost to the Department.

As an exception to the above and upon approval of the Engineer, obtain an engineering analysis by an independent laboratory (as approved by the Engineer) to determine the disposition of the material. The engineering analysis must be signed and sealed by a Professional Engineer licensed in the State of Florida.

The Engineer may determine that an engineering analysis is not necessary or may perform an engineering analysis to determine the disposition of the material.

Any material that remains in place will be accepted with a composite pay factor as determined by 334-8, or as determined by the Engineer.

If the defective material is due to a gradation, asphalt binder content or density failure, upon approval of the Engineer the Contractor may perform delineation tests on roadway cores in lieu of an engineering analysis to determine the limits of the defective material that requires removal and replacement. Prior to any delineation testing, all sampling locations shall be approved by the Engineer. All delineation sampling and testing shall be monitored and verified by the Engineer. The minimum limit of removal of defective material is fifty-feet either side of the failed sample. For materials that are defective due to air voids, an engineering analysis is required.

334-6 Comparison Testing.

At the start of the project (unless waived by the Engineer) and at other times as determined necessary by the Engineer, provide split samples for comparison testing with the Engineer. The purpose of these tests is to verify that the testing equipment is functioning properly and that the testing procedures are being performed correctly. In the event that the Engineer determines that there is a problem with the Contractor's testing equipment and/or testing procedures, immediately correct the problem to the Engineer's satisfaction. In the event that the problem is not immediately corrected, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Engineer.

If so agreed to by both the Contractor and the Engineer, the split sample used for comparison testing may also be used for the Quality Control sample. The split sample used for comparison testing will also meet the requirements for Independent Verification Testing described in 334-5.7.

334-7 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons.

The bid price for the asphalt mix will include the cost of the liquid asphalt or the asphalt recycling agent and the tack coat application as directed in 300-8. There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. For the calculation of unit price adjustments of bituminous material, the average asphalt content will be based on the percentage specified in 9-2.1.2. The weight will be determined as provided in 320-2 (including the provisions for the automatic recordation system).

Prepare a Certification of Quantities, using the Department's current approved form, for the certified Superpave asphalt concrete pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

334-8 Basis of Payment.

334-8.1 General: Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

Based upon the quality of the material, a pay adjustment will be applied to the bid price of the material as determined on a LOT by LOT basis. The pay adjustment will be assessed by calculating a Pay Factor for the following individual quality characteristics: pavement density, air voids, asphalt binder content, and the percentage passing the No. 200 and No. 8 sieves. The pay adjustment will be computed by multiplying a Composite Pay Factor for the LOT by the bid price per ton. Perform all calculations with the Department's Asphalt Plant - Pay Factor Worksheets (Form No. 675-030-22).

334-8.2 Pay Factors:

334-8.2.1 Two or Less Sublot Test Results: In the event that two or less sublot test results are available for a LOT, Pay Factors will be determined based on Table 334-6, using the average of the accumulated deviations from the target value. (Deviations are absolute values with no plus or minus signs.) Use the 1-Test column when there is only one sublot test result and use the 2-Tests column when there are two sublots.

Table 334-6
Small Quantity Pay Table

Pay Factor	1 Sublot Test Deviation	2 Sublot Test Average Deviation
Asphalt Binder Content		
1.05	0.00-0.23	0.00-0.16
1.00	0.24-0.45	0.17-0.32
0.90	0.46-0.55	0.33-0.39
0.80	>0.55	>0.39
No. 8 Sieve		
1.05	0.00-2.25	0.00-1.59
1.00	2.26-4.50	1.60-3.18
0.90	4.51-5.50	3.19-3.89
0.80	>5.50	>3.89
No. 200 Sieve		
1.05	0.00-0.55	0.00-0.39
1.00	0.56-1.10	0.40-0.78
0.90	1.11-1.50	0.79-1.06
0.80	>1.50	>1.06
Air Voids (Coarse Mixes)		
1.05	0.00-0.55	0.00-0.39
1.00	0.56-1.10	0.40-0.78
0.90	1.11-2.00	0.79-1.41
0.80	2.01-2.25	1.42-1.59
0.70	2.26-2.50	1.60-1.77
0.55	>2.50	>1.77
Air Voids (Fine Mixes)		
1.05	0.00-0.50	0.00-0.35
1.00	0.51-1.00	0.36-0.71
0.90	1.01-1.70	0.72-1.20
0.80	1.71-2.00	1.21-1.41
0.70	2.01-2.50	1.42-1.77
0.55	>2.50	>1.77
Density (Coarse Mixes) Note (1)		
1.05	0.00-0.50	0.00-0.35
1.00	0.51-1.00	0.36-0.71
0.95	1.01-1.50	0.72-1.06
0.90	>1.50	>1.06

Table 334-6 Small Quantity Pay Table		
Pay Factor	1 Sublot Test Deviation	2 Sublot Test Average Deviation
Density (Fine Graded Mixtures) Note (1)		
1.05	0.00-0.50	0.00-0.35
1.00	0.51-1.00	0.36-0.71
0.95	1.01-2.00	0.72-1.41
0.90	2.01-3.00	1.42-2.12
0.80	>3.00	>2.12

Notes:
(1) Each density test result is the average of five cores. The target density for coarse mixes is 94.50 percent of G_{mm}. The target density for fine mixes is 93.00 percent of G_{mm} (92.00 percent when compaction is limited to the static mode as defined in Note 1 of Table 334-7)

334-8.2.2 Three or More Sublot Test Results: When three or more sublot test results are available for a LOT, the variability-unknown, standard deviation method will be used to determine the estimated percentage of the LOT that is within specification limits. The number of significant figures used in the calculations will be in accordance with requirements of AASHTO R 11-82 (2002), Absolute Method.

334-8.2.2.1 Percent Within Limits: The percent within limits (PWL) and Pay Factors for the LOT will be calculated as described below. Variables used in the calculations are as follows:

x = individual test value (sublot)
n = number of tests (sublots)
s = sample standard deviation
$\Sigma(x^2)$ = summation of squares of individual test values
$(\Sigma x)^2$ = summation of individual test values squared
Q_U = upper quality index
USL = upper specification limit (target value plus upper specification limit from Table 334-7)
Q_L = lower quality index
LSL = lower specification limit (target value minus lower specification limit from Table 334-7)
P_U = estimated percentage below the USL
P_L = estimated percentage above the LSL

(1) Calculate the arithmetic mean $\left(\overline{X}\right)$ of the test values:

$$\overline{X} = \frac{\sum x}{n}$$

(2) Calculate the sample standard deviation (s):

$$s = \sqrt{\frac{n\sum\left(x^2\right) - \left(\sum x\right)^2}{n(n-1)}}$$

(3) Calculate the upper quality index (Q_U):

$$Q_U = \frac{\text{USL - } \overline{\text{X}}}{\text{s}}$$

(4) Calculate the lower quality index (Q_L):

$$Q_L = \frac{\overline{X} - LSL}{s}$$

(5) From Table 334-8, determine the percentage of work below the USL (P_U).

(6) From Table 334-8, determine percentage of work above the LSL (P_L) Note: If USL or LSL is not specified; percentages within (USL or LSL) will be 100.

(7) If Q_U or Q_L is a negative number, then calculate the percent within limits for Q_U or Q_L as follows: enter Table 334-8 with the positive value of Q_U or Q_L and obtain the corresponding percent within limits for the proper sample size. Subtract this number from 100.00. The resulting number is the value to be used in the next step (Step 8) for the calculation of quality level.

(8) Calculate the percent within limits (PWL) = ($P_U + P_L$) - 100

(9) Calculate the Pay Factor (PF) for each quality characteristic using the equation given in 334-8.2.2.2.

Table 334-7 Specification Limits	
Quality Characteristic	Specification Limits
Passing No. 8 sieve (percent)	Target ± 3.1
Passing No. 200 sieve (percent)	Target ± 1.0
Asphalt Content (percent)	Target ± 0.40
Air Voids - Coarse Mixes (percent)	4.00 ± 1.40
Air Voids - Fine Mixes (percent)	4.00 ± 1.20
Density - Coarse Mixes (percent of G_{mm}):	94.50 ± 1.30
Density - Fine Mixes (percent of G_{mm}):	93.00 + 2.00, - 1.20 (1)
Note (1): If the Engineer (or Contract Documents) limits compaction to the static mode only, the specification limits are as follows: 92.00 + 3.00, -1.20. No additional compensation, cost or time, shall be made.	

Table 334-8 Percent Within Limits				
Quality Index	Percent within Limits for Selected Sample Size			
	n = 3	n = 4	n = 5	n = 6
0.00	50.00	50.00	50.00	50.00
0.05	51.38	51.67	51.78	51.84
0.10	52.76	53.33	53.56	53.67
0.15	54.15	55.00	55.33	55.50
0.20	55.54	56.67	57.10	57.32
0.25	56.95	58.33	58.87	59.14
0.30	58.37	60.00	60.63	60.94
0.35	59.80	61.67	62.38	62.73
0.40	61.26	63.33	64.12	64.51

Table 334-8 Percent Within Limits				
Quality Index	Percent within Limits for Selected Sample Size			
	n = 3	n = 4	n = 5	n = 6
0.45	62.74	65.00	65.84	66.27
0.50	64.25	66.67	67.56	68.00
0.55	65.80	68.33	69.26	69.72
0.60	67.39	70.00	70.95	71.41
0.65	69.03	71.67	72.61	73.08
0.70	70.73	73.33	74.26	74.71
0.75	72.50	75.00	75.89	76.32
0.80	74.36	76.67	77.49	77.89
0.85	76.33	78.33	79.07	79.43
0.90	78.45	80.00	80.62	80.93
0.95	80.75	81.67	82.14	82.39
1.00	83.33	83.33	83.64	83.80
1.05	86.34	85.00	85.09	85.18
1.10	90.16	86.67	86.52	86.50
1.15	97.13	88.33	87.90	87.78
1.20	100.00	90.00	89.24	89.01
1.25	100.00	91.67	90.54	90.19
1.30	100.00	93.33	91.79	91.31
1.35	100.00	95.00	92.98	92.37
1.40	100.00	96.67	94.12	93.37
1.45	100.00	98.33	95.19	94.32
1.50	100.00	100.00	96.20	95.19
1.55	100.00	100.00	97.13	96.00
1.60	100.00	100.00	97.97	96.75
1.65	100.00	100.00	98.72	97.42
1.70	100.00	100.00	99.34	98.02
1.75	100.00	100.00	99.81	98.55
1.80	100.00	100.00	100.00	98.99
1.85	100.00	100.00	100.00	99.36
1.90	100.00	100.00	100.00	99.65
1.95	100.00	100.00	100.00	99.85
2.00	100.00	100.00	100.00	99.97
2.05	100.00	100.00	100.00	100.00
2.10	100.00	100.00	100.00	100.00
2.15	100.00	100.00	100.00	100.00
2.20	100.00	100.00	100.00	100.00

Table 334-8 Percent Within Limits				
Quality Index	Percent within Limits for Selected Sample Size			
	n = 3	n = 4	n = 5	n = 6
2.25	100.00	100.00	100.00	100.00
2.30	100.00	100.00	100.00	100.00
2.35	100.00	100.00	100.00	100.00
2.40	100.00	100.00	100.00	100.00
2.45	100.00	100.00	100.00	100.00
2.50	100.00	100.00	100.00	100.00
2.55	100.00	100.00	100.00	100.00
2.60	100.00	100.00	100.00	100.00
2.65	100.00	100.00	100.00	100.00

334-8.2.2.2 Pay Factors (PF): Pay Factors will be calculated by using the following equation:

Pay Factor = (55 + 0.5 x PWL) / 100

The PWL is determined from Step (8) of 334-8.2.2.1.

334-8.3 Composite Pay Factor (CPF): A Composite Pay Factor for the LOT will be calculated based on the individual Pay Factors (PF) with the following weighting applied: 35 percent Density (D), 25 percent Air Voids (V_a), 25 percent asphalt binder content (P_b), 10 percent Passing No. 200 (P_{-200}) and 5 percent Passing No. 8 (P_{-8}). Calculate the CPF by using the following formula:

CPF = [(0.350 x PF D) + (0.250 x PF V_a) + (0.250 x PF P_b) +
(0.100 X PF P_{-200}) + (0.050 x PF P_{-8})]

Where the Pay Factor (PF) for each quality characteristic is determined in either 334-8.2.1 or 334-8.2.2, depending on the number of sublot tests. Note that the number after each multiplication will be rounded to the nearest 0.01.

The pay adjustment shall be computed by multiplying the Composite Pay Factor for the LOT by the bid price per ton.

334-8.4 Payment: Payment will be made under:

Item No. 334- 1- Superpave Asphaltic Concrete - per ton.

APPENDIX A3

List of Section Titles in Florida's State Standard Specification Manual (SSSM) that Support

FDOT Section 334A and Section 334

STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION 2007

APPENDIX B1

Addendum to Mn/DOT 2360 Plant Mixed Asphalt Pavement

for Airfields under 60,000# Gross Weight

Addendum to Mn/DOT 2360 Plant Mixed Asphalt Pavement for Airfields under 60,000# Gross Weight

Mn/DOT 2360 Plant Mixed Asphalt Pavement, inclusive, and all other referenced parts of Minnesota Department of Transportation, Standard Specifications for Road and Bridge Construction, Current Edition, are applicable except as modified herein.

Equivalent Terms for this Specification, and throughout the application of Mn/DOT 2360 are listed below:

Department, synonymous with Airport Owner [or Owner Authorized Representative]

Engineer, synonymous with Airport Owner [or Owner Authorized Representative]

Roadway, synonymous with Airport Pavement

2360.1 A (4) Delete existing Table 2360.1-A and replace with the following

Airfield Traffic Level (ATL)	MNDOT 2360 traffic levels *(Marshall)*	Airfield Loading Aircraft Gross Wt.	MNDOT ESAL's	
A	3, *(MV)*	≤ 12,500#	1 to <3	
B	4	12,500 to <60,000	3 to <10	

2360.1 A (5) Delete existing 3.0% Air Void option

Delete 2360.2 A2h, A2i and A2j.

Replace 2360.2 E, Gradation Requirements, with the following:

- Marshall Method - The aggregate gradation must be specified from Table #2. The gradations are defined by maximum aggregate size (MAS), which is the sieve size that is one size larger than the first sieve to retain material.

- Table #2 gradation bands are from the FAA P-401 and P-403 specifications and provide a 1½-inch, 1.0-inch, ¾-inch, and ½-inch MAS. The 1½-inch MAS (from P-403) is normally reserved for base course layers
- while the ½-inch MAS (from P-403) is primary used as a leveling material for very thin lifts. The ¾-inch MAS and the 1-inch MAS (from P-401 and P-403) are the dominant aggregate gradations used for base and surface course mixes.
- Superpave Method - The aggregate gradations must be specified from Table #3. The gradations are defined by nominal maximum aggregate size (NMAS), which is one sieve size larger than the first sieve to retain more than 10 percent. Generally, the NMAS is one sieve size smaller that the MAS. Table #3 aggregate gradations are representative of the NMAS Superpave mixtures with gradations requirements based on control points established by AASHTO M 323. The combined aggregate gradation shall be classified as coarse-graded when it passes below the Primary Control Sieve (PCS) control point as defined in AASHTO M 323. All other gradations shall be classified as fine-graded. For both Traffic Level A and B surface courses, the fine-graded aggregate classification has demonstrated excellent performance for HMA airport pavements and should be specified. Also, for airport pavement surface courses, the Superpave 1/2 -inch (12.5 mm) NMAS aggregate gradation is commonly specified. For leveling, intermediate, and base courses, the Superpave NMAS aggregate classification from Table #3 will be specified, respectively, at the discretion of the design engineer.

Table #2 - Aggregate Gradation, After FAA Item P-401 & P-403.

Sieve Size	All Pavements			
	Percent by Weight Passing Sieves			
	1 1/2 in MAS	1.0 in. MAS	3/4 in. MAS	1/2 in. MAS
1.5 in.(37.5 mm)	100	100	100	100
1.0 in.(25.0 mm)	86 to 98	100	100	100
¾ in.(19.0 mm)	68 to 93	76 to 98	100	100
½ in.(12.5 mm)	57 to 81	66 to 86	79 to 99	100
⅜ in.(9.5 mm)	49 to 69	57 to 77	68 to 88	79 to 99
No. 4(4.75 mm)	34 to 54	40 to 60	48 to 68	58 to 78

No. 8(2.36 mm)	22 to42	26 to 46	33 to 53	39 to 59
No. 16(1.18 mm)	13 to 33	17 to 37	20 to 40	26 to 46
No. 30(0.600 mm)	8 to 24	8 to 24	14 to 30	19 to 35
No. 50 (0.300 mm)	6 to 18	4 to 12	9 to 21	12 to 24
No. 100(0.150 mm)	4 to 12	6 to 16	6 to 16	7 to 17
No. 200 (0.075 mm)	3 to 6	3 to 6	3 to 6	3 to 6

Table 3 - Aggregate Gradation, After FAA Item P-401(SP) and AASHTO M 323.

Sieve Size	All Pavements				
	Percent by Weight Passing Sieves				
	1 1/2 in NMAS	1.0 in. NMAS	3/4 in NMAS	1/2 in NMAS	3/8 in NMAS
	(37.5 mm)	(25.0 mm)	(19 mm)	(12.5 mm)	(9.5 mm)
	Control Points	Control Points	Control Points	Control Points	Control Points
1.5 in (50.0 mm)	100 to 100				
1.25 in (37.5 mm)	90 to 100	100 to 100			
1.0 in.(25.0 mm)		90 to 100	100 to 100		
¾ in.(19.0 mm)	90 to 100		90 to 100	100 to 100	
½ in.(12.5 mm)				90 to 100	100 to 100
⅜ in.(9.5 mm)					90 to 100
No. 4(4.75 mm)					
No. 8(2.36 mm)	15 to 41	19 to 45	23 to 49	28 to 58	32 to 67

No. 16(1.18 mm)					
No. 30(0.600 mm)					
No. 50 (0.300 mm)					
No. 100(0.150 mm)					
No. 200 (0.075 mm)	0 to 6	1 to 7	2 to 8	2 to 10	2 to 10

Table 2360.3-B2a - Change the maximum allowable RAP percentages to 15% for all wear and 30% for all Non Wear lifts.

Table 2360.3-B2b - Change Gyrations for Ndesign to 50 for Traffic Level 2 and 3 and Ndesign to 65 for Traffic Level 4. Change all Tensile Strength Ratio requirements to a minimum of 75 for both Contractor Quality Control and Airport Owners test results. Add a Marshall Flow requirement for Marshall designed mixtures of 10 -18 (0.01 in.).

Section 2360.3-D1 - Change 2 working days to 15 working days.

Replace Section 2360.3-D2 – with the following:

> Prior to full production, the contractor shall prepare and place a quantity of HMA mixture according to the job mix formula. As a minimum, and since joint density is require for acceptance, the amount of mixture shall be sufficient to construct a test section a minimum of 300 ft. long and 30 ft. wide**,** placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. A cold joint is an exposed construction joint at least 4 hours old or whose mat has cooled to less than 160° F. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. The test section must be evaluated for acceptance as a single lot in accordance with the acceptance criteria specified in the SSHP specifications, or as specified in other sections referenced in the SSSM, except as modified herein. The test section shall be divided into equal sublots. As a minimum, the test section shall consist of three sublots. The test section shall be considered acceptable if it meets the acceptance criteria specified in the SSHP specification, or as specified in other sections referenced in the SSSM, or as modified herein.

Section 2360.4-B Re-title this section as Quality Assurance and Acceptance Testing. Add the following, “and meet the requirements of ASTM D 3666” to the end of the first line of the section.

Delete Section 2360.4-B(7)

Add a new Section 2360.4-B1- Acceptance testing program. The testing program defined as Contractor Quality Control Section 2360.4-D and E will be conducted by the Engineer from split QC samples and analyzed for acceptance and payment in accordance with Section 2360.4-L

Add the following to Section 2360.4-C2 after the first sentence, "Unless otherwise directed by the Engineer, the lab shall be available for joint use by the Contractor for quality control testing and by the Engineer for acceptance testing. The Engineer shall have priority in use of the equipment necessary for acceptance testing."

Delete Table 2360.4-D and the Sentence immediately preceding Table 2360.4-D.

Section 2360.4-E, Table 2360.4-E - Change the gradation testing frequency to a minimum of 1 per 1000 tons.

Delete Section 2360.4-E1(a) and (d).

Section 2360.4-E9 – All Minimum Tensile Strength Ratio values shown in the Tables shall be 75%.

Delete Sections 2360.4-M and N

Delete the content of Section 2360.6-B2 (Required Density) and replace with the following:

Minimum pavement and longitudinal joint density requirements for both gyratory (SP) and Marshall designed mixtures are listed
in Table 2360.6-B2.

Joint Density. The lot size shall be the total length of longitudinal joints constructed by the same lot determined for the PPM and shall be divided into four equal sublots. For each sublot, the same number of joint core(s) shall be taken, as required by the SSHP specifications for the mat.

Table 2360.6-B2
Required Minimum Average Lot Density (%Gmm)

	Average Lot Density		Individual Test Ranges*	
	Target Value	Tolerances	Min.	Max.
Pavement Density	94.5%	±1.0%	92%	97%
Longitudinal Joints	93.0%	±2.0%	91%	97%

- No individual test result may exceed the individual test ranges shown.

Delete Table 2360.4-B4A and footnote 1.

Table 2360.6-B4 Payment Schedule for Maximum Density must be re-written by the agency to determine price adjustments for the higher density levels required in Table 2360.6-B2. The maximum rate of payment is to be 100%. Change footnote 4 to reflect minimum values of 92% for pavement and 91% for longitudinal joints.

Delete Section 2360.6-C

Replace Section 2360.7-B(2) with the following:

> The finished surfaces of the pavement shall not vary more than 1/4 inch for the surface course. Each lot shall be evaluated with a 16-foot straightedge. The lot size shall be 2,000 square yards. Measurements will be made perpendicular and parallel to the centerline at distances not to exceed 50 feet. When 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area and replace with new material. Sufficient material shall be removed to allow at least two inches of asphalt concrete to be placed. Skin patching shall not be permitted. Isolated grinding of high points may be permitted in lieu of removal and replacement provided the total area of the high point is less than 15 square yards.

Delete Sections 2360.7-B(4), (5) and (6).

Delete Section 2360.7-C

APPENDIX B2

(2360) Plant Mixed Asphalt Pavement Combined 2360/2350 (Gyratory/Marshall Design) Specification

(2360) PLANT MIXED ASPHALT PAVEMENT

Combined 2360/2350 (Gyratory/Marshall Design) Specification
December 11, 2007

This Specification requires the Contractor to provide a mix that complies with all of the design, production, and placement requirements of the specification. The Department does not make any guaranty or warranty, either express or implied, that compliance with one part of this specification guarantees that the Contractor will meet the other aspects of the specification.

All Sections titled 2360 also apply to 2350.

2360.1 DESCRIPTION

This work consists of the construction of one or more pavement courses of hot plant mixed asphalt-aggregate mixture on the approved prepared foundation, base course or existing surface in accordance with the specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. Mixture design will be either 2360 or 2350 (gyratory or Marshall) as described in the Special Provisions through the mixture designation.

A Mixture Designations

Mixture designations for asphalt mixtures contain the following information:

(1) The first two letters indicate the mixture design type:
SP = Gyratory Mixture Design
LV = Marshall Mixture Design – Low Volume, 50 blow
MV = Marshall Mixture Design – Medium Volume, 50 blow
SM = Gyratory Mixture Design for Stone Matrix Asphalt (SMA)

(2) The third and fourth letters indicate the course:
WE = Wearing and Shoulder Wearing Course
NW = Non-Wearing Course

(3) The fifth letter or number indicates the maximum aggregate size*:
A or 4 = 12.5mm [**1/2 inch**], SP 9.5
B or 3 = 19.0mm [**3/4 inch**], SP 12.5
C or 2 = 25.0mm [**1 inch**], SP 19.0
5 = 9.5mm [**3/8 inch**], (Marshall design only)
E = See provision for SMA design
* Letter is used in gyratory designation; number is used in Marshall designation

(4) **For Gyratory Design**:
The sixth digit indicates the Traffic Level (ESAL's x 10^6)
The requirements for gyratory mixtures in this specification are based on the 20-year design traffic level of the Project expressed in Equivalent Single Axle Loads (ESAL's). The five traffic levels are shown below in Table 2360.1-A.

Table 2360.1-A
Traffic Levels

Traffic Level	20 Year Design ESAL's (1 x 10^6 ESAL's)
2^1 <	1
3^2	1 to < 3
4	3 to < 10
5	10 to ≤ 30
6 SM	A

1 -- (AADT # 2300)
2 -- (2300< AADT <6000)

For Marshall Design:
The sixth and seventh digit indicate the Marshall design blows:
50 blow design for both LV and MV mixtures

(5) The last two digits indicate the air void requirement:
40 = 4.0% for SP and SM Wear mixtures
35 = 3.5% for MV Wear and Non-Wear
30 = 3.0% for LV Wear and Non-Wear and SP Non-Wear and Shoulder

(6) The letter at the end of the mixture designation identifies the asphalt binder grade:

Standard Grades	Specialty Grades
B = PG 58-28	A = PG 52-34
C = PG 58-34	H = PG 70-28
E = PG 64-28	
F = PG 64-34	
L = PG 64-22	

Ex: Gyratory Mixture Designation -- SPWEB540E (Design Type, Lift, Agg Size, Traffic Level, Voids, Binder)
Ex: Marshall Mixture Designation – LVWE35030B (Mix Type, Lift, Agg Size, Marshall blows, Voids, Binder)
Ex: SMA Mixture Designation -- SMWEE640H (Design Type, Lift, Agg Size, Traffic Level, Voids, Binder)

B Minimum Lift thickness
Minimum paving lift thickness will be based on maximum aggregate size:

Aggregate Size 5*:	Minimum Lift thickness = 12 mm [**1/2 inch**]
Aggregate Size A, 4*:	Minimum Lift thickness = 25 mm [**1 inch**]
Aggregate Size B, 3*:	Minimum Lift thickness = 40 mm [**1 ½ inch**]
Aggregate Size C, 2* (for non-wear only):	Minimum Lift thickness = 65 mm [**2 ½ inch**]

* Marshall designation

2360.2 MATERIALS

A Aggregate

A1 General

The aggregate shall consist of sound, durable particles of gravel and sand, crushed stone and sand, or combinations thereof. It shall be free of objectionable matter such as metal, glass, wood, plastic, brick, rubber, and any other material having similar characteristics. Coarse aggregate shall be free from coatings of clay and silt to the satisfaction of the Engineer.

The Contractor shall not compensate for the lack of fines by adding soil materials such as clay, loam, or silt. Overburden shall not be blended into the asphalt aggregate.

Each different material (source, class, kind, or size) shall be fed at a uniform rate from its storage unit. An individual source, class, type, or size of material shall not be stockpile blended with another source, class, type or size of material.

A2 Classification

The aggregate shall conform to one of the following classifications. The class of aggregate to be used shall be the Contractor's option unless otherwise specified in the Contract.

A2a Class A

Class A aggregate shall consist of crushed igneous bedrock (specifically; basalt, gabbro, granite, rhyolite, diorite and andosite) and rock from the Sioux Quartzite Formation. Other igneous or metamorphic rock may be used with specific approval of the Engineer. Class A materials may contain no more than 4.0% non-Class A aggregate. This recognizes the fact that some quarries may contain small pockets of non-Class A material within that source. Intentional blending or addition of non-Class A material is strictly prohibited!

A2b Class B

Class B aggregate shall consist of crushed rock from all other bedrock sources such as carbonate and metamorphic rocks. (gneiss or schist)

A2c Class C

Class C aggregate shall consist of natural or partly crushed natural gravel obtained from a natural gravel deposit.

A2d Class D

Class D aggregate shall consist of 100 percent crushed natural gravel. The crushed gravel shall be produced from material retained on a square mesh sieve having an opening at least twice as large as the Specification permits for the maximum size of the aggregate in the composite asphalt mixture. The amount of carryover (material finer than) the selected screen shall not exceed ten percent.

A2e Class E

Class E aggregate shall consist of a mixture of any two or more of the above classes of approved aggregate (A, B, and D). The use of Class E aggregate, as well as the relative proportions of the different constituent aggregates, shall be subject to the approval of the Engineer. The relative proportions of the constituent aggregates shall be accurately controlled either by the use of a blending belt approved by the Engineer prior to production or by separately weighing each aggregate during batching operations.

A2f Steel Slag

Steel slag may not exceed 25 percent of the mass of the total aggregate. Steel slag shall be free of metallics and other mill waste. Stockpiles will be accepted for use if the total expansion, determined by ASTM D4792, is less than 0.50%.

A2g Taconite Tailings (TT)

Taconite tailings shall be obtained from ore that is mined westerly of a north-south line located east of Biwabik, Mn (R15W-R16W); except that taconite tailings from ore mined in southwestern Wisconsin will also be permitted for use.

Approved taconite tailing sources are on file with the Department Bituminous Engineer.

A2h Scrap Asphalt Shingles

Scrap asphalt shingles may be included in both wear and non-wear courses to a maximum of 5 percent of the total weight of mixture. Only scrap asphalt shingles from manufacturing waste are suitable. The percentage of scrap shingles used will be considered part of the maximum allowable RAP percentage (see Table 2360.3-B2a). Refer to Section 2360.2 G1 to select a virgin asphalt binder grade (use requirements for > 20% RAP, regardless of total RAP/shingle percentage). Scrap Shingle Specifications are on file in the Bituminous Office.

A2i Crushed Concrete and Salvaged Aggregate

Crushed concrete is allowed as an aggregate source for up to 50 percent of the aggregate in non-wear mixtures. Crushed concrete is not allowed in wearing courses.

Salvaged aggregate is allowed as an aggregate source for up to 100 percent of the aggregate in wear and non-wear mixtures. All salvaged aggregate shall be stockpiled uniformly to limit variation in mixture properties. Salvaged aggregates shall meet quality and crushing requirements as specified herein.

A2j Sewage Sludge Ash (SSA)

Sewage sludge ash is allowed as an aggregate source in both wear and non-wear courses to a maximum of 5 percent of the total weight of mixture. Only SSA that meets the Tier II hazard evaluation criteria as approved by Mn/DOT's Office of Environmental Services, Environmental Analysis Section, will be allowed for use in the mixture.

Approved waste incinerator ash sources are on file with the Department Bituminous Engineer.

A3 Recycled Asphaltic Pavement Materials (RAP)

The combined RAP and virgin aggregate shall meet the composite fine aggregate angularity or calculated crushed requirements (both coarse and fine aggregate) for the mixture being produced (calculated crushed allowed for Marshall design only). RAP containing any objectionable material, i.e., road tar, metal, glass, wood, plastic, brick, fabric, or any other objectionable material having similar characteristics will not be permitted for use in the asphalt pavement mixture.

Asphalt binder content in the RAP shall be determined according to Mn/DOT Lab Manual Method 1851 or 1852.

B Manufactured Crushed Fines (-4 material)

All Class A, B, D, and E material that passes the 4.75 mm [**#4**] screen will be considered as crushed fines.

Manufactured Crushed Fines (-4 material) from Class C Aggregate. Produce manufactured crushed fines (-4 material) from a gravel source by passing the gravel over a selected screen, 9.5 mm [**3/8 inch**] or larger, prior to mechanical crushing. The material which passes the 9.5 mm [**3/8 inch**] screen shall not be incorporated into the manufactured crushed fines but may be used as it qualifies for natural sand. The amount of carryover (material finer than) the selected screen shall not exceed ten percent.

The material retained on the 9.5 mm [**3/8 inch**] screen shall be crushed. The material that passes the 4.75 mm [**#4**] screen, after crushing, will be considered as 100% crushed fines. Material retained on the 4.75 mm [**#4**] screen after crushing will not be counted as +4 crushing until tested.

C Quality Requirements

C1 Los Angeles Rattler Test.. AASHTO T96

The Los Angeles Rattler loss on the coarse aggregate fraction (material retained on the 4.75 mm [**#4**] sieve shall not exceed 40 percent for any individual source used within the mix. An aggregate proportion which passes the 4.75 mm [**#4**] sieve and exceeds 40 percent LAR loss on the coarse aggregate fraction is prohibited from use in the mixture.

C2 Soundness (Magnesium Sulfate) .... AASHTO T104

The magnesium sulfate soundness loss at 5 cycles on the coarse aggregate fraction (material retained on the 4.75 mm [**#4**]) shall not exceed the following for any individual source used within the mix: *****

a) No more than 14 % loss on the 19 mm [**3/4 inch**] to 12.5 mm [**1/2 inch**] and larger fractions.
b) No more than 18% loss on the 12.5 mm [**1/2 inch**] to 9.5 mm [**3/8 inch**] fraction.
c) No more than 23% loss on the 9.5 mm [**3/8 inch**] to 4.75 mm [**#4**] fraction.
d) No more than 18% for the composite loss. (Applies only if all three size fractions are tested).

* 1) If the composite requirement is met but one or more individual components do not, the source may be accepted if no individual component is more than 110% of the requirement for that component.

2) If each individual component requirement is met but the composite does not, the source may be accepted if the composite is no greater than 110% of the requirement.

Coarse aggregate that exceeds the requirements listed above shall not be processed for use as minus 4.75 mm [**#4**] material.

C3 Spall Materials and Lumps .... Mn/DOT Laboratory Manual

Spall is defined as shale, iron oxide, unsound cherts, pyrite, highly weathered and/or soft phyllite and argillite (may be scratched with a brass pencil), and other materials having similar characteristics.

Lumps are defined as loosely bonded aggregations and clayey masses. If the percent of lumps measured in the stockpile or cold feed exceed the values listed below, asphalt production shall cease and compliance shall be determined by dry batching. This procedure may be repeated at any time at the discretion of the Engineer.

Maximum limits for Spall and lumps, expressed as percentages by mass, are listed in Table 2360.3-B2a.

C4 Insoluble Residue Test.. Mn/DOT Laboratory Manual

If Class B carbonate material is used in the mix, the minus 0.075 mm [**#200**] sieve size portion of the insoluble residue shall not exceed 10 percent.

D Aggregate Restrictions

Class B carbonate aggregate restrictions are specified in Table 2360.3-B2a.

E Gradation Requirement

The coarse and fine aggregate shall be combined in such proportions to produce an asphalt mixture meeting all of the requirements defined in this specification and shall conform to the gradation as defined in Table 2360.2-E. Gradation testing shall be conducted in accordance with AASHTO T-11 (-0.075 mm [-**#200**] wash) and T-27.

Table 2360.2-E
Aggregate Gradation Broad Bands
(% passing of total washed gradation)

Sieve Size (mm [**inch**])	A or 4*	B or 3*	C or 2*	5*	E (SMA)
25.0 [**1 inch**]			100		See SMA Provisions
19.0 [**3/4 inch**]		100(1)	85-100		
12.5 [**1/2 inch**] 1	00(1) 85	-100	45-90		
9.5 [**3/8 inch**] 85	-100	35-90	-	100	
4.75 [**#4**]	25-90 30	-80 30	-75	65-95	
2.36 [**#8**]	20-70 25	-65 25	-60	45-80	
0.075 [**#200**]	2.0-7.0 2.	0-7.0 2.	0-7.0	2.0-7.0	

*M arshall Designation

(1) The gradation broadband for the maximum aggregate size may be reduced to 97% passing for mixtures containing RAP, when the oversize material is suspected to come from the RAP source. The virgin material must remain 100% passing the maximum aggregate sieve size.

F Additives

An additive is any material added to an asphalt mixture or material, such as mineral filler, hydrated lime, asphalt additives, anti-strip, and similar products that do not have a specific pay item. When a Contract requires additives, compensation is included with the pay items for the appropriate mixture. If the Engineer directs the Contractor to incorporate additives, the compensation will be as Extra Work, at the unit price specified in the proposal. The Department will not compensate the Contractor for additives incorporated at the Contractor's option.

Additives will not be incorporated into the mixture without approval of the Department Bituminous Engineer. Anti-foaming agents shall be added to asphalt cement at the manufacturer's recommended dosage rate. Mineral filler and hydrated lime may be added in a quantity not to exceed 5 percent and 2 percent, respectively, of the total mass of the aggregate. The combination of mineral filler and hydrated lime shall not exceed 5 percent of the total mass of aggregate. The Engineer will approve or disapprove methods for addition of additives.

F1 Mineral Filler 3145

F2 Hydrated Lime 3145

Hydrated lime used in asphalt mixtures shall meet the requirements of ASTM C977 and have a maximum of eight percent unhydrated oxides (as received basis). The method of introducing and mixing the hydrated lime and aggregate shall be subject to approval by the Engineer prior to beginning mixture production.

F3 Liquid Anti-Stripping Additive

When a liquid anti-strip additive is added to the asphalt binder, blending shall be completed before the asphalt binder is mixed with the aggregate. Liquid anti-strip additives that alter the asphalt binder, such that it fails to meet the Performance Grade (PG) requirements, shall not be used. Liquid anti-strip may be added by the supplier at the refinery or by the Contractor at the plant site. The company/supplier adding the additive shall be responsible for testing the binder/additive blend to ensure compliance with the AASHTO M 320, Standard Specification for Performance Graded Asphalt Binder. No paving will be allowed until the asphalt binder/additive blend has been tested and results show that binder/additive blend properties meet the criteria in Section 2360.2G. The testing shall be done in accordance with a Mn/DOT approved Asphalt Binder QC Plan. Requirements for the Asphalt Binder QC Plan are on file in the Bituminous Office.

The following requirements for HMA mixture and asphalt binder must also be met when liquid anti-strip is added at the HMA plant site.

Mixture Requirements at Design:

1) The Contractor must design the mixture with the same asphalt binder that will be supplied to the plant site. (Both Laboratory Mixture Design (Option 1) and Modified Mixture Design (Option 2).
2) The Contractor must provide documentation with either design option that includes Tensile Strength Ratio results with the liquid anti-strip dosed at the optimal rate. Documentation must include verification the binder/additive blend meets AASHTO M 320 at the optimal dose rate.

Contractor Production Testing Requirements for Asphalt Binder/Liquid Anti-Strip Blend:

1) The Contractor shall, on a daily basis, sample and test the asphalt binder/anti-strip blend. Testing of the blend can be by viscosity, penetration, or dynamic shear rheometer (DSR). When a polymer modified asphalt binder is specified, the Contractor shall use the DSR as the daily QC test.
2) The Contractor shall, on a weekly basis, send the Engineer and Mn/DOT Chemical Laboratory Director a weekly QC report summarizing the results of the daily testing as required in number 1.
3) The Contractor shall, on a bi-weekly basis, test the binder/anti-strip blend to ensure compliance with the AASHTO M 320, Standard Specification for Performance Graded Asphalt Binder (minimum 1/project). Test results shall be sent to the Engineer and Mn/DOT Chemical Laboratory Director.
4) In addition to the sampling requirements listed above, the Contractor shall obtain asphalt binder/anti-strip blend field verification samples according to 2360.4 E12.

Liquid Anti-Strip Additive Metering System:

1) The metering system shall include a liquid anti-strip flow meter in addition to an anti-strip pump. The flow meter shall be connected to the liquid anti-strip supply to measure and display only the anti-strip being fed to the asphalt binder.
2) The meter readout shall be positioned for convenient observation.
3) There shall be a means provided for comparing the flow meter readout with the calculated output of the anti-strip pump. See number 7.
4) The system shall display in units of liters [**gallons**] to the nearest liter [**gallon**] or in units of metric tons [**tons**] to the nearest 0.001 metric tons [**0.001 tons**], the accumulated anti-strip quantity being delivered to the mixer unit.
5) The system shall be calibrated and adjusted to maintain an accuracy of ± one percent error.
6) Calibration shall be required for each plant set-up prior to production of mixture.
7) The Engineer may require, on a daily basis, the Contractor "stick" the anti-strip tank at the end of the days production to verify anti-strip usage quantities.
8) The system shall provide for a convenient method for sampling the binder/anti-strip after blending has occurred.
9) Alternative blending and metering systems must be pre-approved by the Engineer

F4 Coating and Anti-Stripping Additive 3161

G Asphalt Binder Material .... AASHTO M 320

Asphalt binder material shall meet the requirements of PG asphalt binder testing tolerances, sampling rates, testing procedures, and acceptance criteria based on the most current Mn/DOT Technical Memorandum, titled "Inspection, Sampling, and Acceptance of Bituminous Materials." The PG asphalt binder cannot be modified with air blowing procedures unless the Department Bituminous Engineer approves it. The Contractor shall not use petroleum distillates such as fuel oil, diesel fuel or other fuels in the asphalt tanks. A statement shall be provided by the supplier for recommended laboratory mixing and compaction temperatures and field maximum mixing and compaction temperatures.

G1 Asphalt Binder Selection Criteria for All Mixtures with RAP

Overlay	**Specified PG Asphalt Binder Grade**	**Virgin Asphalt Binder Grade to be used with RAP**	
		≤ 20% RAP	**> 20% RAP**
	All PG Grades	No grade adjustment	No grade adjustment

New Construction [1]	**Specified PG Asphalt Binder Grade**	**Virgin Asphalt Binder Grade to be used with RAP**	
		≤ 20% RAP	**> 20% RAP**
	52-34 52	-34 52	-34
	58-28 58	-28 58	-28
58	-34	58-34	Not allowed *
	64-28 64	-28 64	-28
64	-34	64-34	Not allowed *
	Other PG Grades	No grade adjustment	Not allowed *

* When approved by the Engineer, the virgin asphalt binder grade can be selected by using the blending chart procedure on file in the Bituminous Office. Mn/DOT may take production samples for information/verification of compliance with a specified asphalt binder grade.

(1) Includes cold inplace recycle, reclaiming, and reconstruction.

2360.3 MIXTURE DESIGN

A Mixture Design General

The asphalt mix may be designed using one of the following two Contractor trial mix design options as described in 2360.3B and 2360.3D. Review of mixture designs will be performed in the District Materials Laboratory where the Project is located. All mixture design test results, documentation, aggregate material samples, and mixture samples, as required by the trial mix design option, shall be submitted to the District Materials Laboratory where the Project is located (Department Bituminous Engineer in Metro area). Unless otherwise authorized by the District Materials Engineer, the addition of aggregates and materials not included in the original mixture submittal is prohibited.

It is the Contractor's responsibility to design a Marshall mixture in accordance with the most current AASHTO T-245, the Asphalt Institute's Mix Design Methods for Asphalt Concrete MS-2, and the Mn/DOT Laboratory Manual such that it meets the requirements of this specification.

For Marshall design, the design air void content of the mixture is dependent on the mixture type, regardless of the location in the pavement structure. Design air void content for LV and MV mixtures is 3.0% and 3.5%, respectively.

It is the Contractor's responsibility to design a gyratory mixture in accordance with the most current AASHTO T-312, the Asphalt Institute's Superpave Mix Design Manual SP-2 (2-hour short term aging period is used for volumetric), and the Mn/DOT Laboratory Manual such that it meets the requirements of this specification.

B Laboratory Mixture Design (Option 1)

To verify Laboratory Mixture Design compliance with these specifications, the Contractor shall submit mixture design test results and documentation as described in Section 2360.3C and the materials described below to the District Materials Laboratory where the Project is located (Department Bituminous Engineer in Metro area). The District Materials Engineer (Department Bituminous Engineer) will issue a Mixture Design Report when the mixture design has been successfully verified.

B1 Aggregate sample

At least 15 working days prior to the start of asphalt production, the Contractor shall submit aggregate samples for quality testing. A 35 kg [**80 pound**] sample of representative aggregate retained on the 4.75 mm sieve [**#4**] and a 15 kg [**35 pound**] sample of material passing the 4.75 mm sieve [**#4**] shall be submitted to the District Materials Laboratory where the Project is located (Bituminous Engineer in Metro area). The Contractor shall provide 24 hour notice of intent to sample aggregates. These samples will be tested for quality of each source, class, type, and size of virgin and non-asphaltic salvage aggregate source used in the mix design. The Contractor shall retain a companion sample of equal size until a Mixture Design Report is issued. Quality requirements are defined in Section 2360.2C.

Aggregates that require the magnesium sulfate soundness test shall be submitted to the Department Bituminous Engineer or District Materials Engineer at least 30 calendar days prior to the start of asphalt production. Dispute resolution procedures for aggregate qualities are on file in the Bituminous Office.

B2 Mixture sample

At least 7 working days prior to the start of asphalt production, the Contractor shall submit in writing a proposed Job Mix Formula (JMF) for each combination of aggregates to be used in the mixture. The JMF will be reviewed in the District Materials Laboratory where the Project is located (Department Bituminous Engineer in Metro area). A Level II Quality Management mix designer must sign the proposed JMF. For each JMF submitted, the Contractor shall include test data to demonstrate conformance to mixture properties as specified in Table’s 2360.3-B2b and 2360.3-B2c. The proposed JMF shall be submitted on forms approved by the Department. In addition, the Contractor shall submit an uncompacted mixture sample plus briquettes compacted at the optimum asphalt content and required compactive effort conforming to the JMF for laboratory examination and evaluation. Mixture sample size and number of compacted briquettes are as follows:

Table 2360.3-B2
Mixture Sample Requirements

Item	Gyratory Design	Marshall Design
Un-compacted Mixture Sample Size	30 Kg [**75 pounds**] 1	8 Kg [**40 pounds**]
Number of compacted briquettes	2	3

B2a Mixture Aggregate Requirements

The aggregate fractions shall be sized, graded, and combined in such proportions that the resulting mixture will meet the requirements listed in Section 2360.2-E and Table 2360.3-B2a shown below.

Table 2360.3-B2a
Mixture Aggregate Requirements

Aggregate Blend Property	Traffic Level 2& LV	Traffic Level 3 & MV	Traffic Level 4	Traffic Level 5	SMA T. Level 6
20 year Design ESAL's	<1 million	1 - 3 million	3 - 10 million	10 – 30 million	See SMA Provisions
Coarse Aggregate Angularity (ASTM D5821) (one face / two face), %- Wear (one face / two face), %- NonWear	30/- 30/-	55 / - 55 / -	85 / 80 60/ -	95 / 90 80 / 75	-
Fine Aggregate Angularity (FAA) (AASHTO T304, Method A) %- Wear %-Non-Wear	40[(2)] 40[(2)]	42[(1)] 40[(1)]	44 40	45 40	-
Flat and Elongated Particles, max[(2)] % by weight, (ASTM D 4791)	-	10 (5:1 ratio)	10 (5:1 ratio)	10 (5:1 ratio)	-
Clay Content[(2)] (AASHTO T 176)	-	-	45	45	-
Total Spall in fraction retained on the 4.75mm [**#4**] sieve – Wear Non-Wear	5.0 5.0	2.5 5.0	1.0 2.5	1.0 2.5	-
Maximum Spall Content in Total Sample – Wear Non-Wear	5.0 5.0	5.0 5.0	1.0 2.5	1.0 2.5	-
Maximum Percent Lumps in fraction retained on the 4.75mm [**#4**] sieve	0.5 0.	5	0.5	0.5	-
Class B Carbonate Restrictions					
Maximum% -4.75mm [**-#4**] Final Lift/All other Lifts	100/100	100/100	80/80	50/80	-
Maximum% +4.75mm [**+#4**] Final Lift/All other Lifts	100/100	100/100	50/100	0/100	-
Gyratory Max. allowable RAP percentage[(3)] Wear / Non Wear	30/40 30/	30	30/30	30/30	
Marshall Max. allowable RAP percentage Wear / Non Wear	30/40	30/30			

(1) For Marshall design, the Contractor may determine –4 crushing by either FAA of uncompacted voids or calculation of crush from the composite blend. The choice must be made prior to start of production. Manufactured crushed fines requirement is 25%. RAP sand will be considered 50% crushed if the angularity index equals or exceeds 40, and 100% crushed if the angularity index equals or exceeds 45.

(2) Not applicable under Marshall design.

(3) When shingles are included as part of the allowable RAP percentage in Traffic Level 4 and Traffic Level 5 mixtures the ratio of added new asphalt binder to total asphalt binder shall be 70% or greater ((added binder/total binder) x 100 >= 70). A minimum of 1 spotcheck per day per mixture blend is required to determine new added binder.

B2b Mixture Requirements

Mixture evaluation will be based on the trial mix tests and the corresponding requirements listed in Table 2360.3-B2b and Table 2360.3-B2c.

Table 2360.3-B2b
Mixture Requirements

Traffic	Level 2	Traffic Level 3	Traffic Level 4	Traffic Level 5	SMA T. Level 6
20 year Design ESAL's	< 1 million	1 - 3 million	3 - 10 million	10 – 30 million	See SMA Provisions
Gyratory Mixture Requirements					
Gyrations for N_{design} 40		60	90	100	-
%Air Voids at N_{design}, -- Wear %Air Voids at N_{design}, -- Non-Wear & All Shoulder	4.0 3.0	4.0 3.0	4.0 3.0	4.0 3.0	-
Tensile Strength Ratio (1), min%	75(2) 75	(2) 80	(3) 80	(3) -	
Fines/Effective Asphalt	0.6 – 1.2	0.6 – 1.2	0.6 – 1.2	0.6 – 1.2	-
VFA, % -- Wear- 4.0% Voids Non-Wear & All Shoulder- 3.0% Voids	65 - 78 70 – 83	65 - 78 70 - 83	65 - 76 70 - 82	65 - 76 70 - 82	
Marshall Mixture Requirements	LV MV				
Marshall Blows	50	50	-	-	-
Air Voids, %	3.0	3.5	-	-	-
Tensile Strength Ratio (1), min%	70(4) 70	(4)			
Stability, minimum N [**lb f**] 5	000 [**1125**] 6	000 [**1350**]			
Fines/Effective Asphalt Wear Non-Wear	0.6 - 1.30 0.6-1.40	0.6 - 1.30 0.6-1.40	- -		-

(1) See Section 2360.4 E9. Use 150mm [**6 inch**] specimens for gyratory and 100mm [**4 inch**] specimens for Marshall design.
(2) Mn/DOT Min = 65, (3) Mn/DOT Min = 70, (4) Mn/DOT Min = 60

B2c VMA Criteria

The voids in mineral aggregate (VMA) of the mixture at design and during production shall meet the minimum criteria as shown in Table 2360.3-B2c at the specified compaction level. VMA shall be calculated according to the procedures outlined in Asphalt Institutes SP-2 or MS-2 manual. VMA is a design and acceptance/process control requirement.

Table 2360.3-B2c
Voids in Mineral Aggregate (VMA) Mixture Requirements

Gradation	Fine Mixture % Pass 2.36 mm [**#8**]	VMA Minimum	Coarse Mixture % Pass 2.36 mm [**#8**]	VMA Minimum
A or 4*	> 47	15.0**	≤ 47	14.5**
B or 3*	> 39	14.0	≤ 39	13.5
C or 2*	> 35	13.0	≤ 35	12.5
5*	-----	15.0**	-----	-----
E	See SMA Provisions			

*Marshall designation.
**For LV 4 and LV 5 mixes lower VMA requirements by 0.5%

B3 Tensile Strength Ratio sample

Mixture or briquettes that represent the mixture at optimum asphalt content, shall be submitted at least 7 days prior to actual production for verification of moisture sensitivity retained tensile strength ratio (TSR). Material submitted for TSR verification may be tested for maximum specific gravity G_{mm} compliance in addition to TSR results. Failure to meet the G_{mm} tolerance will result in rejection of the submitted mix design. A new mix design submittal will be required and will be subject to provisions described in Section 2360.3C. One of the following options may be used to verify that the tensile strength ratio (TSR) meets the requirements in Table 2360.3-B2b.

Option A) The Contractor will batch material at the design proportions including optimum asphalt. Immediately (before curing) split the sample and allow samples to cool to room temperature. Submit 35 kg [**77 pounds**] of mixture to the District Materials Laboratory for curing and test verification. Both groups will use a two (2) hour cure time (± 15 minutes) at 144°C [**290°F**] and follow procedures in ASTM D 4867-92, Mn/DOT modified as defined in the Mn/DOT Laboratory Manual.

Option B) The Contractor batches, cures (as indicated in option A), compacts, and submits briquettes and uncompacted mixture as specified below.

Table 2360.3-B3
Option B Mixture Requirements

Item	Gyratory Design	Marshall Design
Un-compacted Mixture Sample Size	8,200 g	8,200 g
Number of compacted briquettes(1)	6	9
Compacted briquette air void content	6.5 – 7.5%	6.0 – 8.0%

(1) 150mm [**6 inch**] specimens for gyratory design
100mm [**4 inch**] specimens for Marshall design

B4 Aggregate Specific Gravity.................................... AASHTO T84 and T85, Mn/DOT Modified

The Contractor shall determine the specific gravity of all aggregate used in the mixture.

C Documentation

Each proposed JMF submitted for review under Section 2360.3B and 2360.3D shall include the following documentation and test results.

(1) The name(s) of the individual(s) responsible for the Quality Control of the mixture during production.
(2) The low projects number on which the mixture will be used.
(3) The design traffic level and the design number of gyrations.
(4) The temperature ranges the mixture is intended to be discharged from the plant and compacted at the roadway shall be provided by the asphalt binder supplier. Temperatures to be included are, laboratory mixing and compaction temperature ranges and maximum field mixing and compaction temperatures..
(5) The percentage in units of 1 percent (except the 0.075 mm sieve [**#200**] in units of 0.1 percent) of aggregate passing each of the specified sieves for each aggregate to be incorporated into the mixture. The gradation of aggregate from salvaged asphaltic material shall be derived from the material after the residual asphalt has been extracted.
(6) The source and description of the materials to be used. The aggregate pit or quarry source number. The proportion of each material (in percent of total aggregate).
(7) The composite gradation based on (5) and (6) above. Note: Include virgin composite gradation based on (6) and (7) above for mixtures containing RAP.
(8) The bulk (dry) and apparent specific gravities and water absorption (by % weight of dry aggregate) of both coarse and fine aggregate, for each product used in the mixture (including RAP). Use AASHTO T-84 and T-85 Mn/DOT modified as defined in the Mn/DOT Laboratory Manual. The tolerance allowed between the Contractor's and the Department's specific gravities are G_{sb} (individual) = 0.040 [+4 AND -4] and G_{sb} (combined) = 0.020.
(9) The composite gradation plotted on a FHWA 0.45 power chart. (Federal form PR-1115)
(10) The test results from the composite aggregate blend at the proposed JMF proportions indicating compliance with Coarse Aggregate Angularity, Fine Aggregate Angularity, and Flat and Elongated as shown in Table 2360.3-B2a.

(11) For mixtures containing RAP include extracted asphalt binder content of the RAP with no retention factor included.

(12) The percentage (in units of 0.1 percent) and PG grade of asphalt binder material to be added, based upon the total mass of the mixture.

(13) Each trial mixture design shall include the following:

(a) A minimum of three different asphalt binder contents (minimum 0.4 percent between each point), with at least one point at, one above and one below the optimum asphalt binder percentage.

(b) The maximum specific gravity at each asphalt binder content. The theoretical maximum specific gravity used for percent air voids determination shall be calculated based on the average of the effective specific gravities measured by a minimum of two maximum specific gravity tests at the asphalt contents above and below the expected optimum asphalt binder content.

(c) The test results for the individual and average bulk specific gravity, density, and heights, of at least two specimens at each asphalt binder content. For Marshall design include the test results for the individual and average bulk specific gravity, density, height, stability, and flow of at least three specimens at each asphalt binder content.

(d) The percent air voids in the mixture at each asphalt binder content.

(e) The percent Voids in Mineral Aggregate (VMA) at each asphalt binder content.

(f) The fines to Effective Asphalt (F/A) ratio calculated to the nearest 0.1 percent.

(g) TSR results at the optimum asphalt binder content.

(h) Graphs showing air voids, voids in the mineral aggregate, Gmb, Gmm and unit weight vs. percent asphalt binder content for each of the three asphalt binder contents submitted with trial mix.

(i) Evidence the completed mixture will conform to design air voids (V_a), VMA, VFA (gyratory), TSR, F/A_e (Fines to effective asphalt ratio).

(j) For gyratory design, the documentation shall also include labeled gyratory densification tables and curves generated from the gyratory compactor for all points used in the mixture submittal.

(14) Optional Add-Rock/Add-Sand Provisions

If the Contractor chooses to use the add-material option to augment the submitted JMF, the Contractor shall provide samples of the aggregate for quality analysis in accordance with Section 2360.3B1. The Contractor shall provide mix design data for two additional design points per add-material. One point shall show a proportional adjustment to the submitted JMF that includes 5 percent, by mass, add-material at the JMF optimum asphalt percent. The second point shall show a proportional adjustment to the submitted JMF that includes 10 percent, by mass, add-material at the JMF optimum asphalt percent. The following information will be reported for each of these two points:

(a) The maximum specific gravity (average of two tests).

(b) The test results for the individual and average bulk specific gravity, density, and height of at least two specimens at the optimum asphalt binder content. For Marshall design include the test results for the individual and average bulk specific gravity, density, height, stability, and flow of at least three specimens at the optimum asphalt binder content.

(c) The percent air voids in the mixture for each point.

(d) The Fines to Effective Asphalt ratio calculated to the nearest 0.1 of a percent.

(e) Coarse and Fine Aggregate crushing counts

Up to two add-materials will be allowed per mix design submittal. Aggregate quality and mix characteristics are required for each proposed add-material and shall be submitted at the time of the original trial mix submittal. No mixture sample or briquettes are required for these two additional points.

D Modified Mixture Design (Option 2)

The Contractor shall submit mixture design test results and documentation as described in Section 2360.3C to the District Materials Laboratory where the Project is located (Department Bituminous Engineer in Metro area) to verify compliance with these specifications. The District Materials Engineer (Department Bituminous Engineer) will issue a Mixture Design Report when the mixture design has been successfully verified. Mixture submittal is not required. The Contractor may use this option if **all** of the following conditions are met:

a) The aggregates must have been tested for and meet all applicable quality requirements in the current construction season.

b) The Level II mix designer submitting the mixture design must have a minimum of 2 years experience in mixture design.

c) The Contractor and his representatives cannot have violated the requirements of 1512 Unacceptable and Unauthorized Work relating to mixture design or mixture production within the last 12 month period.

D1 JMF Submittal

At least 2 working days prior to the start of asphalt production, the Contractor shall submit in writing a proposed Job Mix Formula (JMF) for each combination of aggregates to the Department Bituminous Engineer or District Materials Engineer for review. A Level II Quality Management mix designer must sign this proposed JMF. For each JMF submitted, the Contractor shall include documentation as outlined in Section 2360.3C to demonstrate conformance to mixture properties as specified in Table 2360.3-B2b and 2360.3-B2c. The proposed JMF shall be submitted on forms approved by the Department.

D2 Initial Production Test Verification

At the start of production, the testing frequency for the first 1,800 metric tons [**2,000 tons**] of each mix type shall be as specified in Table 2360.4-D.

All mixture placed on Mn/DOT projects shall meet the specified quality indicators and required field density. Failure to do so will result in reduced payment or removal and replacement with acceptable material.

The Department shall take a mix verification sample within the first four samples at the start of production of each mix type.

D3 Tensile Strength Ratio sample

See Section 2360.4E9

D4 Marshall Stability (Marshall Design Only)

On the first day of production, for each different mix design, at the same time the verification sample is obtained, an additional sample shall be obtained for Department evaluation of Marshall stability. This sample may be tested at the discretion of the District Materials Engineer. The Contractor is not required to test stability on production mixture.

If the Marshall stability fails to meet the minimum requirements as listed in Table 2360.3-B2c the Contractor shall stop production immediately. The Contractor will be required to submit a revised mix design, with bituminous mixture at optimum asphalt content, to the District Materials Laboratory. If the mixture meets the minimum stability requirement production may be resumed.

If the stability fails the second time, the Mix Design Report will be revoked. The Contractor will then be required to submit a new mix design according to Laboratory Mixture Design 2360.3B, Option 1. A new Mix Design Report will be issued upon successful verification of the new mixture design submittal.

E Mixture Design Report

A Mixture Design Report consists of the JMF (Job Mix Formula). The JMF includes composite gradation, aggregate component proportions, asphalt binder content of the mixture, design air voids, Voids in Mineral Aggregate, and aggregate bulk specific gravity values. JMF limits will be shown for gradation control sieves, percent asphalt binder content, air voids, and VMA. Issuance of a Mixture Design Report confirms the mixture has been reviewed for and meets volumetric properties only. No guaranty or warranty, either express or implied, is made regarding placement and compaction of the mixture

A Department reviewed Mixture Design Report is required for all paving except for small quantities of material provided under Section 2360.5H. All submitted materials must meet aggregate and mixture design requirements before a Mixture Design Report is issued. The Department will review two trial mix designs per mix type designated in the plan, per Contract at no cost to the Contractor. Additional mix designs will be verified at a cost of $2000 per design, payable to the Commissioner of Transportation.

For city, county, and other agency projects, the Contractor shall provide to the District Materials Laboratory a complete Project proposal including addenda, supplemental agreements, change orders, and any Plan sheets (including typical sections) that affect the mix design. The Department will not start the verification process without this information.

2360.4 MIXTURE QUALITY MANAGEMENT (Quality Control/Quality Assurance)

A Quality Control (QC)

The Contractor shall provide and maintain a quality control program for HMA production. A quality control program is defined as all activities, including mix design, process control inspection, sampling and testing, and necessary adjustments in the process that are related to the production of a hot mix asphalt (HMA) pavement which meets the requirements of the specifications.

A1 Contractor Certified Plant HMA

A1a Certification Procedure

The Contractor shall:

(1) Complete application form and request for plant inspection.

(2) Provide a site map of stockpile locations.

(3) Pass plant and testing facility inspection by having the Plant Inspector and Bituminous Plant Authorized Agent complete and sign the Asphalt Plant Inspection Report (TP 02142-02, TP 02143-02). By signing the Asphalt Plant Inspection Report, the HMA plant authorized agent agrees to calibrate and maintain all plant and laboratory equipment within allowable tolerances set forth in these specifications, Standard Specifications for Construction, and the Mn/DOT Bituminous Manual.

(4) Obtain a Mixture Design Report prior to production.

A1b Maintaining Certification

To maintain certification, the plant must produce, test, and document all certified plant asphalt mixtures in accordance with the above requirements on a continuous basis. Continuous basis means all asphalt mixtures supplied from a certified plant to any Department project with 2360 asphalt mixtures must be sampled and tested in accordance with 2360 requirements and the Schedule of Materials Control.

The Contractor shall assure the plant certification procedure is performed annually after winter suspension and before producing material for a Project. In addition, a first-day sampling and testing frequency rate as stated in Table 2360.4-D shall be followed.

The Contractor shall recertify a plant when it is moved to a new location or a previously occupied location.

A1c Revocation of Plant Certification

The Department Construction Engineer may revoke certification of an asphalt plant when requirements are not being met or records are falsified. The Department may revoke the Technician Certification for the individual involved.

The Department Bituminous Engineer and Department Contract Administrator will maintain a list of companies who have had their asphalt plant certification revoked.

B Quality Assurance (QA)

The Department will perform QA testing as part of the acceptance process. The Engineer is responsible for QA testing, records, and acceptance. The Engineer will accomplish the QA process by:

(1) Conducting Quality assurance and verification sampling and testing.
(2) Observing sampling and tests performed by the QC personnel.
(3) Taking additional samples at any time and any location during production.
(4) Monitoring the required QC summary sheets and control charts.
(5) Verifying calibration of laboratory testing equipment.
(6) Communicating Mn/DOT test results to the Contractor's QC personnel in a timely manner (See 2360.4M and 2360.4N).
(7) Ensuring Independent Assurance Sampling and testing requirements are met.

C Contractor's Quality Control

C1 Personnel Requirements

Along with the proposed mix design data, the Contractor shall submit to the Engineer an organizational chart listing the names and phone numbers of individuals and alternates responsible for mix design, process control administration, and inspection. The Contractor shall also post a current organizational chart and if required by the Engineer, post a daily roster of individuals performing QC testing in the Contractor's test facility.

The Contractor's quality control organization or private testing firm shall have Certified Technicians who have met the requirements on file with the Department's Technical Certification program. Individuals performing process control testing must be certified as a Level I Bituminous Quality Management (QM) Tester. Individuals performing mix design calculations or mix design adjustments must be certified as Level II Bituminous QM Mix Designer. The Contractor shall have a Certified Level II Bituminous QM Mix Designer available to make any necessary process adjustments. The Contractor shall have a minimum of one person per paving operation certified as a Level II Bituminous Street Inspector.

C2 Laboratory Requirements:

The Contractor shall furnish and maintain a laboratory at the plant site or other site as approved by the Engineer. The laboratory shall be furnished with the necessary equipment and supplies for performing Contractor quality control testing. The laboratory equipment shall meet the requirements listed in Section 400 of the Mn/DOT Bituminous Manual, Mn/DOT Lab Manual, and these specifications, including having extraction capabilities. The laboratory shall be calibrated and operational prior to the beginning of production. In addition to the requirements listed above, the laboratory shall be equipped with a telephone for use by the Contractor or the Engineer. A fax machine and copy machine shall be available for use by the Contractor or the Engineer at the laboratory site. The Engineer may waive the requirement to have a fax machine available at the laboratory site if transfer of data and test results can be accomplished through electronic transmittal (email). The laboratory shall also include a computer and printer. The computer shall have the following minimum requirements: 1) Intel based with either Celeron or Pentium IV processor with a minimum processor speed of 1.8 MHZ. 2) CD writer with CD/RW capability and a minimum write speed of 16x. 3) Windows 2000 or Windows XP with Microsoft Excel version 97 or newer. The printer must be able to print control charts.

The Engineer shall be allowed to inspect measuring and testing devices to confirm both calibration and condition. The Contractor shall calibrate and correlate all testing equipment in accordance with the latest version of the Mn/DOT Bituminous Manual and Mn/DOT Lab Manual. Records of calibration for each piece of testing equipment shall be kept in the same facility as the equipment.

D Sampling and Testing

The Contractor shall ensure that all QC samples are taken at random locations. Random number generation and determination of random sample location shall be consistent with the Mn/DOT Bituminous Manual Section 5-693.7 Table A or Section 5 of ASTM D3665. The Engineer may approve alternate methods of random number generation.

The tests for mixture properties shall be conducted on representative portions of the mix, quartered from a larger sample of mixture taken from behind the paver, or when approved by the Engineer, an alternate sampling location. The procedure for truck box sampling, an alternate sampling location, is on file in the Bituminous Office. When an alternate sampling location is approved and used by the Contractor, the daily verification sample must still be taken from behind the paver.

The Contractor shall obtain a sample of at least 25 kg [**55 pounds**]. This sample may be either split in the field or transported to the test facility by a method to retain heat to facilitate sample quartering procedures. The Contractor shall store and retain mixture bulk samples and companion samples for the Department for a period of 7 working days. The Contractor shall maintain these split samples in containers labeled with companion numbers. The Contractor shall perform QC sampling and testing according to the following schedule.

Determine the planned tonnage for each mixture to be produced during the production day. Divide the planned production by 1000. Round the number to the next higher whole number. This number will be the number of production tests required for that mixture. Required production tests are listed in Table 2360.4-E. Split the planned production into even increments and select sample locations as described above. If actual tonnage exceeds planned tonnage additional tests may be required. During production, mixture volumetric property tests will not be required when mix production is less than 270 metric tons [**300 tons**]. However, production tests will be required when the accumulative tonnage on successive days exceeds 270 metric tons [**300 tons**].

At the start of production, the testing frequency for the first 1800 metric tons [**2,000 tons**] of each mix type shall be as follows:

Table 2360.4-D
Production Start-Up Testing Rates

Production Test	Testing Rates	Test Reference	Section
Bulk Specific Gravity	1 test per 450 metric tons [**500 tons**]	AASHTO T312,T166 Mn/DOT modified	2360.4E2
Maximum Specific Gravity	1 test per 450 metric tons [**500 tons**]	AASHTO T209 Mn/DOT modified	2360.4E3
Air Voids (calculated)	1 test per 450 metric tons [**500 tons**]	AASHTO T269, T312	2360.4E4
Asphalt Content	1 test per 450 metric tons [**500 tons**]	Bit & Lab Manual	2360.4E1
VMA (Calculated)	1 test per 450 metric tons [**500 tons**]	AI MS 2 & SP 2	2360.4E5
Gradation	1 test per 900 metric tons [**1000 tons**]	AASHTO T11, T27, T30Mn/DOT modified	2360.4E6
Coarse Aggregate Angularity	1 test per 900 metric tons [**1000 tons**]	ASTM D5821	2360.4E7
Fine Aggregate Angularity (FAA)(1)	1 test per 900 metric tons [**1000 tons**]	AASHTO T304, Method A	2360.4E8

(1) Marshall design allows -4.75mm [**-#4**] manufactured crushed fines calculation per Mn/DOT Bituminous Manual

E Production Tests

When more than one Mn/DOT approved test procedure is available, the Contractor shall select, with the approval of the Engineer, one method at the beginning of the Project and use that method for the entire Project. The Contractor and Engineer may agree to change test procedures during the construction of the Project.

Table 2360.4-E
Production Sampling and Testing Rates

Production Test	Sampling/Testing Rates	Test Reference	Section
Bulk Specific Gravity	Divide the planned production by 1000. Round the number to the next higher whole number.	AASHTO T312, T245 T166 Mn/DOT mod	2360.4E2
Maximum Specific Gravity	"	AASHTO T209 Mn/DOT modified	2360.4E3
Air Voids (calculated)	"	AASHTO T269, T312	2360.4E4
Asphalt Content	"	Bit & Lab Manual	2360.4E1
VMA (Calculated)	"	AI MS 2 & SP 2	2360.4E5
Gradation	1 gradation per 1,800 metric tons [**2,000 tons**], or portion thereof (minimum of one per day)	AASHTO T11, T27, T30Mn/DOT modified	2360.4E6
Coarse Aggregate Angularity	2 tests/day for a minimum of 2 days, then 1 per day if CAA is met. If CAA >8% of requirement, 1 sample/day but test 1/week.	ASTM D5821	2360.4E7
Fine Aggregate Angularity (FAA)(1)	2 tests/day for a minimum of 2 days, then 1 per day if FAA is met. If FAA >5% of requirement, 1 sample/day but test 1/week.	AASHTO T304, Method A	2360.4E8
TSR	1st sample at 5,000 tons or by second day of production, then sample at every 18,000 metric tons [**20,000 tons**]	ASTM D4867 Mn/DOT modified	2360.4E9
Aggregate Specific Gravity	1 per 9,000 metric tons [**10,000 tons**]	AASHTO T84 & T85, Mn/DOT modified	2360.4E10
Mixture Moisture Content	Daily unless exempted by Engineer	Mn/DOT 5-693.950	2360.4E11
Asphalt Binder	Sample 1st load (each grade) then 1 per 1,000,000 liter [**250,000 gallon-sample size 1 quart**.]	Mn/DOT 5-693.920	2360.4E12

(1) Marshall design allows -4.75mm [**-#4**] manufactured crushed fines calculation per Mn/DOT Bituminous Manual

E1 Asphalt Binder Content [2]

(a) Spot Check (Virgin only) .... Mn/DOT Bituminous Manual
(b) Incinerator Oven [1] .... Mn/DOT Laboratory Manual Method 1853
(c) Chemical Extraction .... Mn/DOT Laboratory Manual Method 1851 or 1852
(d) Meter Method (Virgin only) .... Mn/DOT Bituminous Manual

(1) Incinerator Oven may not be used when the percentage of Class B material exceeds 50% within the composite blend, unless a correction factor is determined by the Contractor and approved by the District Materials Engineer.
(2) For Traffic Level 4 and 5 mixtures that include shingles as part of the allowable RAP percentage a minimum of 1 spotcheck per day per mixture blend is required to determine new added asphalt binder (See footnote 3 of Table 2360.3-B2a).

E2 Marshall Bulk Specific Gravity, G_{mb} (3 specimens) ..... AASHTO T166, Mn/DOT Modified, or

E2a Gyratory Bulk Specific Gravity, G_{mb} (2 specimens) .... AASHTO T312, T166, Mn/DOT Modified

E3 Maximum Specific Gravity, G_{mm} .... AASHTO T209, Mn/DOT Modified

E4 Air Voids - Individual and Isolated (calculation) .... AASHTO T269, T312

Isolated air voids are calculated using the maximum mixture specific gravity and the corresponding bulk specific gravity from a single test. Individual air voids are calculated from the maximum specific gravity moving average and the bulk specific gravity from that single test.

For gyratory design, compaction shall be conducted to N_{design}, as shown in Table 2360.3-B2a, for the specified Traffic Level.

E5 Voids Mineral Aggregate (VMA) (calculation) .... Asphalt Institute MS-2, SP-2

E6 Gradation - Blended Aggregate .... AASHTO T-11, T-27, and T-30 (all Mn/DOT modified)

Testing to determine the blended aggregate gradation shall be determined every 1800 metric tons [**2,000 tons**], or portion thereof (minimum of one per day), on samples taken at the same time as the required mixture sample for a given increment.

All gradations require a - 0.075 mm [**-#200**] wash.

(a) Virgin Aggregate Mixtures - Drum or Screenless Plants
Belt Samples or extracted production samples.
(b) All Other Mixtures:
1. Hot Bins - Drybatch (Optional)
2. Incinerator Oven Mn/DOT Laboratory Manual Method 1853 (Optional) except samples that contain over 50% class B. [1]
3. Extraction Mn/DOT Laboratory Manual Method 1851 or 1852 (Optional)

(1) Incinerator Oven may not be used when the percentage of Class B material exceeds 50% within the composite blend, unless a correction factor is determined by the Contractor and approved by the District Materials Engineer.

E7 Coarse Aggregate Angularity .... ASTM D5821

CAA test results shall meet the minimum percent fractured faces as shown in Table 2360.3-B2a. ASTM D-5821 shall be used to determine coarse aggregate angularity on the composite blend from aggregates used in production of hot mix asphalt. Mixtures that contain virgin aggregates may be tested from composite belt samples. Mixtures that contain RAP must be tested from extracted aggregates taken from standard production samples. The percentage of fractured faces of the composite aggregate blend less than 100% shall be tested at the following rates:

(1) Perform two tests per day for each mixture blend for a minimum of two days and then one per day if the test samples meet CAA requirements.
(2) If CAA crushing test results exceed 8 percent of the requirement, take one sample per day and perform one test per week.

CAA results must be reported on the test summary sheet. Mixture placed and represented by results below the minimum requirement, as shown in Table 2360.3-B2a, will be subject to reduced payment as outlined in Table 2360.4-L3. Tonnage subjected to reduced payment shall be calculated as the tons placed from the sample point of the failing test until the sampling point when the test result is back within specifications.

E8 Fine Aggregate Angularity .... ASTM C1252 Method A

FAA test results shall meet the minimum criteria shown in Table 2360.3-B2a. ASTM C1252 Method A shall be used to determine fine aggregate angularity on the composite blend from aggregates used in production of HMA. Mixtures that contain virgin aggregates may be tested from composite belt samples. Mixtures that contain RAP must be tested from extracted aggregates taken from standard production samples. The percentage of uncompacted voids from the composite aggregate blend shall be tested at the following rates.

(1) Perform two tests per day for each mixture blend for a minimum of two days and then one per day if the test samples meet FAA requirements.
(2) If FAA test results exceed 5 percent of the requirement, take one sample per day and perform one test per week.

FAA results must be reported on the test summary sheet. Mixture placed and represented by results below the minimums, as shown in Table 2360.3-B2a, will be subject to reduced payment as outlined in Table 2360.4-L3. Tonnage is subjected to reduced payment shall be calculated as the tons placed from the sample point of the failing test until the sampling point when the test result is back within specifications.

E8a - 4.75 mm [-#4] Manufactured Crushed Fines....... (calculation) Mn/DOT Bituminous Manual

Under Marshall design, when the -4.75 mm [**-#4**] crushing is calculated, adjustments in target values from the composite blend must be made at the end of each days paving. If the target quantity (percent of -4.75 mm [**-#4**] to be crushed) changes due to mixture proportion or composite gradation change, a new target shall be established for the next days paving.

E9 Field Tensile Strength Ratio (TSR) .... ASTM D4867 Mn/DOT Modified

At the discretion of the Materials Engineer, mixture will be sampled and tested to verify tensile strength ratio (TSR)[(1)]. If the Materials Engineer requires sampling and testing, both the Contractor and the Department will be required to test these samples within 72 hours after it is sampled. Sample size shall be 50 kg [**110 pound**] minimum and split in half to provide a sample for the Department and the Contractor. The Department companion of this split shall be labeled with the date, time, Project number and approximate cumulative tonnage to date. The Department companion shall be given to the Department Street Inspector or Plant Monitor immediately or delivered to the District Materials Engineer within 24 hours of sampling, as specified by the Engineer. Mixture samples shall be taken from behind the paver unless the Engineer approves an alternate sampling location. Specimen size shall be 100 mm [**4 inch**] for Marshall mix design and 150 mm [**6 inch**] for gyratory design The Contractor may test the sample at a permanent lab site or a field lab site.

(1) When utilizing Option 2 mix design, it is recommended a sample be obtained within the first 4,500 metric tons [**5,000 tons**] of HMA produced or by the second day of production, whichever comes first, to verify tensile strength ratio (TSR).

Minimum acceptable TSR values for production are shown in Table 2360.4-E9. The Contractor shall stop production immediately if minimum TSR requirements are not met. The Contractor will not be allowed to resume production until anti-strip has been added to the asphalt binder. Determination of who is responsible for the cost of the anti-strip is based on Mn/DOT and Contractor TSR values as outlined in Tables 2360.4E9A, 2360.4E9B, and 2360.4E9C. When Mn/DOT is responsible for the cost of the anti-strip, payment will be made only for the cost of the anti-strip for mixtures placed on that project. Mn/DOT will not reimburse the Contractor for any delay costs associated with making changes related to this testing.

Table 2360.4-E9

Mixture Type- - Minimum TSR					
LV and MV		Gyratory Traffic Level 2-3		Traffic Level 4-5	
Contractor	Mn/DOT	Contractor	Mn/DOT	Contractor	Mn/DOT
70%	60%	75%	65%	80%	70%

Table 2360.4-E9A

LV and MV Mixtures		**Contractor TSR**	
		≥70	<70
Mn/DOT TSR	≥60	NA	Mn/DOT
	<60	Contractor	Contractor

Table 2360.4-E9B

Gyratory Level 2-3		**Contractor TSR**	
		≥75	<75
Mn/DOT TSR	≥65	NA	Mn/DOT
	<65	Contractor	Contractor

Table 2360.4-E9C

Gyratory Level 4-5		**Contractor TSR**	
		≥80	<80
Mn/DOT TSR	≥70	NA	Mn/DOT
	<70	Contractor	Contractor

Another sample shall be taken and tested within the first 450 metric tons [**500 tons**] after production resumes. If the re-test fails to meet the minimum specified value the Contractor shall stop production immediately. Production cannot resume until the Contractor has discussed, with the Engineer, a proposal for resolving the problem. The Contractor shall not operate below the specified minimum TSR on a continuing basis. A continuing basis shall be defined as 2 or more successive tests failing the TSR requirements.

The following conditions will automatically require a sample to be taken and tested:

1. A proportion change of more than 10 percent (from the currently produced mixture) for a single stockpile aggregate.
2. The discretion of the Engineer.

Dispute resolution procedures for TSR are on file in the Bituminous Office.

E10 Aggregate Specific Gravity (Gsb)..........................AASHTO T84 and T85, Mn/DOT modified

At the discretion of the District Materials Engineer, aggregate stockpiles will be sampled and tested to verify aggregate specific gravity. Representative stockpile samples shall be 40 kg [**90 pounds**] for each aggregate component. All samples shall be split in half to provide material for both the Department and the Contractor. The Department companion of this split shall be labeled with the date, time, Project number and approximate cumulative tonnage to date.

The Department companion shall be given to the Plant Monitor immediately or delivered to the District Materials Engineer within 48 hours of sampling, as specified by the Engineer. Aggregate specific gravity results will be compared to the Contractor's values on the current Mix Design Report. If the results deviate beyond the tolerance specified in Table 2360.4-M, the District Materials Engineer will immediately contact the Contractor and issue a new Mix Design Report with the current specific gravity results. Any mixture placed following notification of new specific gravity values will be based upon Department results. The Contractor shall be notified immediately when new specific gravity values become available and what impact this will have on the calculated VMA. The dispute resolution procedure for aggregate specific gravity is on file in the Bituminous Office.

E11 Moisture Content ....Mn/DOT 5-693.950

Provide a mixture with moisture content not greater than 0.3 percent. The moisture content in the mixture shall be measured behind the paver or alternate approved sampling method on file in the Bituminous Office. Sampling and testing shall be conducted by the Contractor on a daily basis unless exempted by the Engineer. Sampling and testing is suggested when rain on stockpiles exceed more than 5 mm [**0.2 inch**] in a 24 hour period. The sample shall be stored in an airtight container. Microwave testing is prohibited.

HMA that exceeds 0.3% moisture content is unacceptable. The Contractor shall take appropriate action to remove excess water from the mixture. This action may include reducing the production rate, mixing stockpile aggregates prior to placement into the feed bins, and use of covered stockpiles.

E12 Asphalt Binder Samples

The Contractor shall sample the first shipment of each type of asphalt binder, then sample at a rate of one per 1,000,000 liters [**250,000 gallons**]; sample size shall be 1.0L [**1 quart**]. All samples shall be taken in accordance with the Mn/DOT Bituminous Manual 5-693.920. Sampling shall be conducted by Contractor and monitored by the Inspector. The Contractor shall record sample information on Asphalt Sample Identification Card. Promptly submit the sample to the Department Materials Laboratory in Maplewood. Contact the Department Chemical Laboratory Director for disposition of failing asphalt binder samples.

F Documentation (Records)

The Contractor shall maintain documentation, including test summary sheets and control charts, on an ongoing basis. The Contractor shall also maintain a file of gyratory specimen heights for all gyratory compacted samples and test worksheets. Reports, records, and diaries developed during the progress of construction activities for the Project, shall be filed as directed by the Engineer and will become the property of the Department. The Contractor shall:

(1) Number test results in accordance with standard Department procedures and record on forms approved/supplied by the Department.

(2) Facsimile or when approved by the Engineer, electronically transmit (email) all production test results on test summary sheets to the District Materials Laboratory and to other sites as requested by the Engineer, by 11 AM of the day following production.

(2a) Include the following production test results and mixture information on the Department approved test summary sheet.

1. Percent passing on sieves listed in Table 2360.2-E
2. Coarse and fine aggregate crushing.
3. Maximum specific gravity ($G_{mm.}$).
4. Bulk specific gravity (G_{mb}).
5. Percent asphalt binder content (P_b).
6. Calculated production air voids (V_a).
7. Calculated voids in mineral aggregate (VMA).
8. Composite aggregate specific gravity (G_{sb}) reflecting current proportions.
9. Ag gregate proportions in use at the time of sampling.
10. To ns where sampled.
11 Cu mulative tons.
11a. Tons Represented by Test.
12. Fines to effective asphalt ratio (F/A_e).
13. Signature Line for Mn/DOT and Contractor Representative.
14. Mixture Moisture Content.
15. Mn/DOT verification sample test result.

(2b) Submit copies of all failing test results to the Engineer on a daily basis.

(3) Provide the Engineer with asphalt manifests or BOL's on a daily basis.

(4) Provide a daily plant diary to include a description of QC actions taken (adjustment of cold feed percentages, changes in JMFs, etc.) include all changes or adjustments on the test summary sheets.

(5) Provide weekly truck scale spot checks.

(6) Provide a Department approved accounting system for all mixes and provide a daily and final Project summary of material quantities and types.

(6a) Provide a final hardcopy summary of all quality control test summary sheets and control charts at completion of bituminous operations on the Project to the Engineer. Because Certified Plant test data often represents test data for multiple projects, it may be necessary to make duplicate copies of the data for each project. The Contractor shall also submit a diskette of the quality control summary sheets, control charts and density worksheets to the Bituminous Engineer.

(7) Furnish an automated weigh scale and computer generated weigh ticket. The ticket shall indicate project number, mix designation (including binder grade), Mixture Design Report#, truck identification and tare, net mass, date and time of loading. Any deviations from the minimum information to be provided on the computer generated weigh ticket must be approved by the Engineer in writing.

(8) Test summary sheets, charts, and records for a mixture produced at one plant site shall be continued from contract to contract. The Contractor shall begin new summary sheets and charts annually for winter carry-over projects.

G Documentation (Control Charts)

The following data shall be recorded on the standardized control charts, all control charts and summary sheets shall be computer generated using software approved by the Engineer. Software is available from the Mn/DOT Bituminous Office at www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp.

(1) Blended aggregate gradation, include sieves shown in Table 2360.2-E for specified mixture.
(2) Percent asphalt binder content (P_b)
(3) Maximum specific gravity ($G_{mm.}$)
(4) Production air voids (V_a)
(5) VM A

Individual test results shall be plotted for each test point. A solid line shall connect individual points. The moving average for each test variable shall be plotted starting with the fourth test. A dashed line shall connect the moving average points. The Department's quality assurance and verification test results shall be plotted with asterisks. Specification JMF limits shall be indicated on the control charts using a dotted line. The Engineer may waive the plotting of control charts.

H JMF Limits

The production air voids and VMA are based upon the minimum specified requirements as shown in Tables 2360.3-B2b and 2360.3B2c. Gradations and asphalt binder content limits are based upon the current Department reviewed Mixture Design Report. Gradation control sieves include each sieve shown in Table 2360.2-E. The mixture production targets are listed on the Mixture Design Report. JMF limits are the target plus or minus the limits shown in Table 2360.4-H. JMF limits are used as the criteria for acceptance of materials based on the moving average. A moving average is the average of the last four test results.

Table 2360.4-H
JMF Limits (N=4)

Item	JMF Limits
VMA, %	- 0.3
Production Air Voids, %	± 1.0
Asphalt Binder Content, %	- 0.4
Sieve - % Passing*	
25, 19, 12.5, 9.5, 4.75 mm [**1 inch, 3/4 inch, 1/2 inch, 3/8 inch, #4**] ±	7
2.36 mm [**#8**]	± 6
0.075 mm [**#200**] ±	2.0

*****JMF limits are not allowed outside the broadband requirements in Table 2360.2-E.

I JMF Bands

JMF Bands are defined as the area between the target, as identified on the Mixture Design Report, and the JMF limits.

J JMF Adjustment

The Contractor shall begin mixture production with the materials (gradation, asphalt content, and aggregate proportions) closely conforming to the reviewed Mixture Design Report. Closely conforming shall be defined as aggregate proportions within 5 percent of the design proportions [(1)] and other mixture parameters within the JMF limits in Table 2360.4-H. This requirement may be waived if the Contractor provides the District Materials Laboratory with prior documented production data showing how production affects the mixture properties or if the Contractor provides the District Materials Laboratory with a written justification or explanation of material changes since the original mixture submittal.

[(1)] The Contractor shall begin mixture production using <u>all</u> aggregate proportions included on the Mixture Design Report unless the aggregate proportion is shown as 0 percent.

J1 JMF Request for Adjustment

If, during production, the Contractor determines from results of QC tests that adjustments to the mix design are necessary to achieve the specified properties, the following provisions shall apply. Unless otherwise authorized by the District Materials Engineer, no adjustments are allowed using aggregates or materials not part of the original mix design.

The Contractor shall make a request for a JMF adjustment to the Department Bituminous Engineer or District Materials Engineer. The requested change will be reviewed for the Department by a Certified Level II Bituminous QM Mix Designer. If the request meets the design requirements in Tables 2360.3-B2a and 2360.3-B2b, a revised Mixture Design Report shall be issued. Each trial mixture design submittal as described in Section 2360.3A may have three JMF adjustments per mixture per project without charge. Additional JMF adjustments requested must be accompanied with a $500 fee per each additional JMF adjustment, payable to the Commissioner of Transportation.

If a JMF change is requested for the 0.075 mm [**#200**] sieve, the Fines to Effective Asphalt Ratio shall be determined on the moving average from the previous four gradation tests conducted during actual production. The adjusted JMF shall be within the mixture specification gradation design broadbands shown in Section 2360.2E. Should a redesign of the mixture become necessary, a new JMF shall be submitted. The JMF asphalt content may only be reduced if the production VMA meets or exceeds the minimum VMA requirement for the mixture being produced.

Adjustments will be made as a result of an interactive process between the Contractor, Engineer, and District Materials Engineer. Consecutive requests for JMF adjustments, without production data, are not allowed. The calculation of the moving average shall continue after the JMF has been approved.

J1a JMF Request for Adjustment for Proportion Change > 10%

If a JMF adjustment is requested for a proportion change exceeding 10% (from the currently produced mixture) for a single stockpile aggregate, supporting production test data from a minimum of four tests run at an accelerated testing rate of 1 test per 450 metric tons [**500 tons**] must be included with the request for adjustment. In addition to the requirements listed above, acceptable verification and approval of the requested JMF will be based on individual and moving average test results. Individual test results must be within twice the requested JMF limits for percent asphalt binder, production air voids, and VMA. Individual gradation must be within twice the requested JMF bands. The moving average values must be within the control limits of Table 2360.4-H. The calculation of the moving average shall continue after the change in proportions.

If the mixture meets the specified quality indicators, the request for JMF adjustment will be signed by the District Materials Laboratory and considered effective from the point the proportion change was made. Failure to meet the quality indicators will result in reduced payment or removal and replacement with acceptable material. Consecutive requests for JMF adjustments without production data are not allowed.

K Corrective Action -- Percent Asphalt Binder Content, VMA, and Gradation and Production Air Voids

When the moving average values trend toward the JMF limits, the Contractor shall take corrective action. The corrective action taken shall be documented on summary sheets and, if applicable, a request for JMF adjustment shall be submitted to the District Materials Engineer for review and approval. All tests shall be part of the project files and shall be included in the moving average calculations. The Contractor shall notify the Engineer whenever the moving average values exceed the JMF limits**.**

L Failing Materials

The determination of price adjustments for failing materials will be based on the criteria outlined in this Section. Material acceptance is based on individual and moving average test results. Isolated test results are used for acceptance of air voids at the start of mixture production. Generally, individual test results which are more than twice the JMF bands are considered failing. Moving average test results are considered failing when they exceed the JMF limits. The Contractor shall begin new summary sheets annually for winter carry-over projects.

If the moving average values exceed the JMF limits, the Contractor shall stop production and make adjustments. The Contractor shall restart production only after notifying the Engineer of the adjustments that have been made. Testing shall resume at the accelerated rates and for the tests listed in Table 2360.4-D for the next 1800 metric tons [**2,000 tons**] of mixture produced. The calculation of the moving average shall continue after the stop in production.

Mixture produced where the moving average of four exceeds the JMF limits shall be considered unsatisfactory and subject to requirements of Section 2360.4L4, L5, L6, and L7. Individual test failures are discussed in Section 2360.4L1, L2, and L3.

When the total production of a mixture type for the entire project requires less than four tests, acceptance of material will be consistent with the criteria outlined in Section 2360.4L1, L2, and L3.

When the Contractor's testing data fails to meet specified tolerances as listed in Table 2360.4-M, quality assurance/verification data shall be used in place of the Contractor's data to determine the appropriate payment factor.

L1 Isolated Failures at Mixture Start-Up – Production Air Voids

At the start-up of mixture production, before a moving average of four can be established the first three (3) isolated test results for production air voids will be used for acceptance. Isolated production air voids are calculated by using the maximum mixture specific gravity and the corresponding bulk specific gravity from that single test. After four (4) samples have been tested and a moving average of four can be established, acceptance will be based on individual and moving average production air voids.

If, at the start of production, any of the first three (3) isolated test results for production air voids exceeds twice the JMF bands from the target listed on the Mixture Design Report, the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage placed from the sample point of the failing test until the sample point when the isolated test result is back within twice the JMF bands. When the failure occurs at the first test, after the start of production, the tonnage subjected to reduce payment shall be calculated as described above and shall include the tonnage from the start of production.

When isolated air voids are less than 1.0% or greater than 7.0% the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. To better define the area to be removed and replaced the Engineer may require the Contractor to test inplace mixture. This may include testing mixture placed prior to the failing test result. Reduced payment will be 50 percent of the Contract bid price.

L2 Individual Failure at Mixture Start-Up – VMA

At the start-up of mixture production, before a moving average of four can be established, the first three (3) individual test results for VMA will be used for acceptance. After 4 samples have been tested and a moving average of four can be established, acceptance will be based on individual and moving average VMA.

If, at the start of production, any of the first three (3) individual VMA test results exceeds twice the JMF bands from the target listed on the Mixture Design Report, the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage placed from the sample point of the failing test until the sample point when the test results are back within twice the JMF limits. When the failure occurs at the first test, after the start of production, the tonnage subjected to reduce payment shall be calculated as described above and shall include the tonnage from the start of production.

L3 Individual Failure - Gradation, Percent Asphalt Binder, Production Air Voids, and VMA

Table 2360.4-L3
Reduced Payment Schedule for Individual Test Results

Item	Pay Factor (1)
Gradation 95	%
Coarse and Fine Aggregate Crushing	90 %
VMA	85 %
Asphalt Binder Content	85 %
Production Air Voids (individual (2) and isolated (3))	80 %

(1) Lowest Pay Factor applies when there are multiple reductions on a single test.
(2) Individual air voids are calculated using the moving average maximum specific gravity and the bulk specific gravity from that single test.
(3) Isolated air voids are calculated from the maximum specific gravity and the bulk specific gravity from that single test. Isolated void test results are used for acceptance only for the first 3 tests after mixture production start-up.

If the individual gradation test exceeds twice the JMF bands from the target listed on the Mixture Design Report the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage represented by the individual test.

If the individual tests for percent asphalt binder content, production air voids, or VMA exceeds twice the JMF bands from the target listed on the Mix Design Report the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage placed from the sample point of the failing test until the sample point when the test result is back within twice the JMF limits. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall be calculated as described above and shall include the tonnage from the start of production that day.

When individual air voids are less than 1.0% or greater than 7.0% the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. To better define the area to be removed and replaced the Engineer may require the Contractor to test inplace mixture. This may include testing mixture placed prior to the failing test result. Reduced payment will be 50 percent of the Contract bid price.

L4 Moving Average Failure at Mixture Start-Up - Production Air Voids

When a moving average failure occurs within any of the first 3 moving average results after mixture start-up (tests 4, 5, 6), the mixture will be considered acceptable if the individual air void, corresponding to the moving average failure is within the JMF limits. If the individual air void is not within the JMF limit, the mixture will be considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. The Engineer may waive the penalty if the isolated air void corresponding to the individual air void is within the JMF limit. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 50 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of the failing moving average result and corresponding individual air void beyond the JMF limit to the sampling point when the individual test result is back within the JMF limit.

L5 Moving Average Failure at Mixture Start-Up - VMA

When a moving average failure occurs within any of the first 3 moving average results after mixture start-up (tests 4, 5, 6), the mixture will be considered acceptable if the individual VMA, corresponding to the moving average failure is within the JMF limits. If the individual VMA is not within the JMF limit, the mixture will be considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 75 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of the failing moving average result and corresponding individual VMA beyond the JMF limit to the sampling point when the individual test result is back within the JMF limit.

L6 Moving Average Failure - Production Air Voids

A moving average production air void failure occurs when the individual production air void moving average of four exceeds the JMF limit. This mixture is considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 70 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of all individual test results beyond the JMF limits which contributed to the moving average value that exceeded the JMF limit to the sampling point when the individual test result is back within the JMF limits. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall include the tonnage from the start of production that day.

Table 2360.4-L6
Reduced Payment Schedule for Moving Average Test Results

Item	**Pay Factor** (1)
Gradation **(SEE FOOTNOTE #3 BELOW)** 75	%(3)
Coarse and Fine Aggregate Crushing	NA (individual failures only)
VMA(2)	75 %
Asphalt Binder Content	75 %
Production Air Voids(2)	70 %

(1) Lowest Pay Factor applies when there are multiple reductions on a single test.
(2) See criteria for mixture production start-up
(3) <u>Excluding the 0.075 mm [#200] sieve, use 95% pay factor if failure is within aggregate gradation broadband, Table 2360.2-E.</u>

L7 Moving Average Failure - Percent Asphalt Binder Content, VMA, and Gradation

For mixture properties including asphalt binder content, VMA, and gradation, where the moving average of four exceeds the JMF limits, the mixture is considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 75 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of all individual test results beyond the JMF limits which contributed to the moving average value that exceeded the JMF limit, to the sampling point when the individual test result is back within the JMF limits. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall include the tonnage from the start of production that day.

L8 Coarse and Fine Aggregate Crushing Failure

If any test result for Coarse Aggregate Angularity, Fine Aggregate Angularity or **-**4.75mm [**- #4**] calculated crushing fail to meet minimum requirements in Table 2360.3-B2a, all material placed is subject to reduced payment as outlined in Table 2360.4-L3. Tonnage subjected to reduced payment shall be calculated as the tons placed from the sample point of the failing test until the sampling point when the test result is back within specifications. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall include the tonnage from the start of production that day.

M Quality Assurance

The Engineer will periodically witness the sampling and testing being performed by the Contractor. If the Engineer observes that the sampling and quality control tests are not being performed in accordance with the applicable test procedures, the Engineer may stop production until corrective action is taken. The Engineer will notify the Contractor of observed deficiencies promptly, both verbally and in writing.

The Engineer may obtain additional samples, at any time, to determine quality levels. These additional samples or verification samples are described in Section 2360.4N. For mixture, the Contractor shall test their portion immediately.

All testing and data analysis shall be performed by the Certified Level I Bituminous Quality Management (QM) Technician. Certification shall be in accordance with the Mn/DOT Technical Certification Program. The Department shall post a chart giving the names and telephone numbers for the personnel responsible for the Quality assurance program.

The Engineer shall calibrate and correlate all laboratory testing equipment in accordance with the latest version of the Mn/DOT Bituminous Manual.

Table 2360.4-M
Allowable Differences (Tolerances) Between Contractor and Mn/DOT Test Results*

Item	Allowable Difference
Mixture Bulk Specific Gravity (G_{mb}) 0.	030
Mixture Maximum Specific Gravity (G_{mm}) 0.	019
VMA (Calculated)	1.2
Fine Aggregate Angularity, uncompacted voids (U) %	1
Coarse Aggregate Angularity, % fractured faces (%P)	15
Aggregate Individual Bulk Specific Gravity (+4.75mm [**+ #4**]) 0.	040
Aggregate Individual Bulk Specific Gravity (-4.75mm [**- #4**])	0.040
Aggregate combined blend Specific Gravity (G_{sb}) 0.	020
Tensile Strength Ratio (TSR) %	See Table 2360.3-B2b
Asphalt Binder Content	
Meter Method, %	0.2
Spot Check Method, %	0.2
Chemical Extraction Methods, %	0.4
Incinerator Oven, %	0.3
Chemical vs. Meter, Spot Check, or Incinerator methods	0.4
Incinerator Oven vs. Spot Check	0.4
Gradation Sieve % passing	
25.0, 19.0, 12.5, 9.5 mm [**1 inch, 3/4 inch, 1/2 inch, 3/8 inch**] 6	
4.75 mm [**#4**] 5	
2.36 mm [**#8**] 4	
0.075 mm [**#200**] 2.	0

*Test tolerances listed are for single test comparisons.

N Verification Testing

A verification sample is a sample, which is sampled and tested by Mn/DOT to assure compliance of the Contractor's Quality Control program. A verification companion is a companion sample, to Mn/DOT's verification sample, provided to the Contractor. The Contractor is required to test and use this verification companion sample as part of the QC program. The verification companion sample will replace the next scheduled QC sample. It is recommended enough material be sampled to accommodate retesting should the samples fail to meet requirements as described below.

Verification testing shall be performed on at least one set of production tests Section 2360.4E, excluding sections E9, E10, E11, and E12, on a daily basis per mix type. The verification companion sample will be used to verify the requirements of Tables 2360.2-E, 2360.3-B2a, 2360.3-B2b, and 2360.3-B2c and will be compared to the Verification sample for compliance with allowable tolerances as specified in Table 2360.4-M. These include the mixture properties of G_{mm} (mixture max gravity), G_{mb} (mixture bulk gravity), asphalt binder content, VMA (calculated), Coarse and Fine Aggregate crushing, and gradation. For Coarse and Fine Aggregate crushing that meets the requirements of Section 2360.4E7 and 2360.4E8 the one test per week shall be performed on a verification companion. These do not include the aggregate bulk specific gravity $G_{sb,}$ fines to effective asphalt, or the tensile strength ratio (TSR). Asphalt binder content and gradation must be determined by either extraction method 2360.4E1b or 2360.4E1c. Asphalt content from the verification test result must be used to determine VMA.

The Department's verification test results will be available to the Contractor within 2 working days from the time the sample is delivered to the District Laboratory for Gmm mixture max gravity, Gmb mixture bulk gravity, air voids (calculated), asphalt binder content, VMA (calculated). Gradation and crushing results will be provided to the Contractor within 3 Mn/DOT working days. Once the verification test results are available, they will be included on the test summary sheet. These results and those from the Contractor's verification companion will be compared for allowable tolerances as specified in Table 2360.4-M. If the tolerances are met, the verification process is complete.

If the tolerances between Department and Contractor are not met, retests of the material shall be conducted by the Department. If the retests fail to meet tolerances, the Department's verification test results will be substituted for the Contractor's results in the QC program and used for acceptance. Only those parameters out of tolerance will be substituted and, if applicable, volumetric properties will be recalculated [(1)].

When tolerances from the verification sample retests are not met, an investigation will begin immediately to determine the cause of the difference. Testing equipment, procedures, worksheets, gyratory specimen height sheets, and personnel will be reviewed to determine the source of the problem. The District Materials Engineer may also require a hot-cold comparison of mixture properties be performed. The procedure for hot-cold comparisons is as follows:

> The hot-cold comparison sample will be split into three representative portions. The Engineer will observe the Contractor testing the sample. One part shall be compacted immediately while still hot (additional heating maybe required to raise the temperature of the sample to compaction temperature). The second and third part will be allowed to cool to air temperature. The Contractor will retain the second part and the third part will be transported to the District Materials Laboratory. On the same day and at approximately the same time the Contractor and the District Materials Laboratory will heat their samples to compaction temperature and compact them. From this information a calibration factor will be developed to compare the specific gravity of the hot compacted samples to reheated compacted samples. Each test will involve a minimum of three Marshall specimens or two gyratory specimens. This test may be repeated at the discretion of the Contractor or the District Materials Engineer.

Note: Care must be taken when reheating samples for mixture properties analysis tests. Mix samples should be reheated to 70°C [**160°F**] to allow splitting of the sample into representative fractions for the various tests. Overheating of the mixture portions to be tested for maximum specific gravity (Rice Test) may result in additional asphalt being absorbed in the aggregate.

The Department will test the previously collected QA samples until they meet the tolerances or the remaining samples are all tested. Once these samples are tested, the department will test QA samples subsequent to the verification sample until tolerances are met. Acceptance will be based on QC data with substitution of Department test results for those parameters out of tolerance [(1)]. If reestablishment of test result tolerances is not achieved within 48 hours, the Contractor shall cease mixture production and placement until the problem is resolved.

(1) If, through analysis of data, it is determined there is a bias in the test results, the Engineer will determine which results are appropriate and shall govern. Methods to analyze data for determination of bias are on file in the Bituminous Office.

2360.5 CONSTRUCTION REQUIREMENTS

A General

The following construction requirements provide for the construction of all courses. When construction is under traffic, the requirements of Mn/DOT 2221.3D will apply.

B Restrictions

In general, no work within the roadway will be permitted in the spring until seasonal load restrictions on roads in the vicinity have been removed. However, work within the roadbed may be permitted before that time if, in the opinion of the Engineer, it can be done without damage to the subgrade. HMA shall not be placed when, in the opinion of the Engineer, the weather or roadbed conditions are unfavorable.

No asphalt pavement wearing course (final wearing course if multiple wearing courses) shall be placed after October 15th in that part of the state north of an east-west line between Browns Valley and Holyoke, nor after November 1st south of that line. The Engineer may waive these restrictions when:

(1) The asphalt mixture is not being placed on the traveled portion of the roadway, or

(2) The roadway involved will not be open to traffic during the following winter, or

(3) The Engineer directs in writing the mixture be placed.

The Contractor shall not use petroleum distillates such as kerosene and fuel oil to prevent adhesion of asphalt mixtures in pavement hoppers, truck beds, or on the contact surfaces of the compaction equipment. Anti-adhesive agent must meet the criteria for "Effect on Asphalt" as described in the most recent Asphalt Release Agent Report on file in Mn/DOT's Office of Environmental Services and the Bituminous Office.

C Equipment

C1 Asphalt Mixing Plants

C1a Requirement for All Plants

The Contractor shall test and calibrate all scales according to Mn/DOT 1901, except as otherwise designated by the Contract.

C1a(1) Equipment for the Preparation of the Aggregate

Add mineral filler to the mixture using a storage silo equipped with a device to ensure a constant and uniform feed.

C1a(2) Equipment for the Preparation of Asphalt Material

Tanks for storage of asphalt material at the plant shall be equipped to heat the material and maintain the material at the required temperatures. The discharge end of the circulating line shall be below the surface of the asphalt material. Provide agitation for modified asphalt, when used, if recommended by the supplier.

An outage table or chart and measuring stick shall be provided for each storage or working tank. Tanks shall be equipped with provisions for taking of asphalt binder material samples. After delivery of asphalt binder material to the Project, the Contractor shall not heat the material above 175°C [**350°F**]. For modified asphalt, the maximum storage temperature shall not exceed the recommendation of the asphalt supplier.

C1a(3) Asphalt Binder Control

When asphalt binder material is proportioned by volume, the plant shall be equipped with either a working tank or a metering system for determining asphalt binder content of the mixture.

The working tank shall have a capacity between 3 800 L [**1,000 gallons**] and 7 600 L [**2,000 gallons**]. The working tank shall be calibrated and supplied with a calibrated measuring stick. The tank may be connected to a mixing unit and used only during spot check operations, but it shall be available at all times. Any feedback shall be returned to the working tank during spot check operations.

The metering system shall consist of at least one approved asphalt binder flow meter in addition to the asphalt binder pump. The flow meter shall be connected to the asphalt binder supply to measure and display only the asphalt binder being fed to the mixer unit. The meter readout shall be positioned for convenient observation. Means shall be provided for comparing the flow meter readout with the calculated output of the asphalt binder pump. In addition, the system shall display in liters [**gallons**] or to the nearest 0.001 metric tons [**0.001 tons**], the accumulated asphalt binder quantity being delivered to the mixer unit. The system shall be calibrated and adjusted to maintain an accuracy of ± one percent error. This calibration shall be required for each plant set-up prior to production of mixture.

C1a(4) Dryer: The aggregate shall be free of unburned fuel.

C1a(5) Thermometric Equipment:

The plant shall be equipped with a sufficient number of thermometric instruments to ensure temperature control of the aggregate and the asphalt binder material.

C1a(6) Pollution Controls

C1a(6)(a) Pollution..1717

C1a(7) Surge and Storage Bins

The plant may include facilities to store hot asphalt mixture for coordinating the rate of production with the paving operations. Storage of the hot mixture will be permitted for a period not to exceed 18 hours, provided the following requirements are met:

(a) Hot mix storage facilities shall be designed and operated to prevent segregation of the mix, drainage of the asphalt from the mix, and to prevent excessive cooling or overheating of the mixture.

(b) The temperature of the mixture at time of discharge from the storage facility shall be within a tolerance of 5°C [**9°F**] of the temperature when discharged from the silo or mixer.

C2 Placement and Hauling Equipment

All equipment shall be serviced away from the paving site to prevent contamination of the mixture. Units that drip fuel, oil, or grease shall be removed from the paved surface until such leakage is corrected.

C2a Asphalt Pavers

Asphalt pavers shall be self-contained, power-propelled units, with an operational vibratory screed, capable of spreading and finishing courses of asphalt plant mix material in widths applicable to the specified typical sections and thicknesses, indicated in the Contract.

The screed or strike-off assembly shall produce a finished surface of the required evenness and texture without tearing, shoving, or gouging. For mainline paving, if the paving width is greater than the basic screed, auger and mainframe extensions, which meet manufacture's recommendations for the paving width, are required unless otherwise directed by the Engineer. Strike-off only extension assemblies are not allowed for mainline wearing course paving, unless directed by the Engineer.

All pavers shall be equipped with an approved automatic screed control. The automatic controls shall include a system of sensor-operated devices, which follow reference lines, or surfaces on one or both sides of the paver as required. The speed of the paver shall be adjusted to produce the best results.

Automatic screed control by means of an erected string line shall only be required when stated in the Contract.

All mixtures shall be spread without segregation to the cross sections shown in the plans. In general, leveling layers shall be spread by the method producing the best results as approved by the Engineer. The objective is to secure a smooth base of uniform grade and cross section so that subsequent courses will be uniform in thickness. The leveling layer may be spread with a properly equipped paver or, when approved by the Engineer, a motor grader equipped with a leveling device, or with other means for controlling the surface elevation of the leveling layer.

All mixtures shall be spread, to the fullest extent practicable, by an asphalt paver. When approved by the Engineer, mixtures may be spread by a motor grader in areas that are inaccessible to a paver such as on driveway entrances, irregular areas, short isolated areas or when the quantity of mixture makes it impractical to place with a paver.

On shoulder surfacing and uniform width widening, when the placement width is too narrow for a paver, the mixture in each course shall be spread with an approved mechanical device.

The placement of each course shall be completed over the full width of the section under construction on each day's run unless otherwise directed by the Engineer.

C2b Trucks

Trucks for hauling asphalt mixtures shall have tight, clean, and smooth beds. Mixture shall not be allowed to adhere to the truck beds. Adherence may be prevented by spraying the truck bed with an anti-adhesive agent in accordance with Section 2360.5B. Each truck shall be equipped with a cover of canvas or other suitable material to protect the mixture from weather. The cover shall extend at least 300 mm [**1 foot**] over the sides and be attached to tie-downs unless the truck is furnished with a mechanical or automated covering system, which prevents airflow underneath by stretching the cover tightly on the top of or inside the sideboards. The cover shall be used when directed by the Engineer.

C2c Motor Graders

Motor graders shall be self-propelled and have pneumatic-tires with a tread depth of 13 mm [**1/2 inch**] or less. They shall be equipped with a blade not less than 3 m [**10 feet**] in length and shall have a wheelbase of not less than 4.5 m [**15 feet**].

D Treatment of the Surface

D1 Tack Coat

An asphalt tack coat shall be applied to existing asphalt and concrete surfaces, and to the surface of each course or lift constructed, except for the final course or lift, according to Mn/DOT 2357. Emulsified asphalt tack coats shall be allowed to break, as indicated by a color change from brown to black, before a subsequent lift is placed.

The contact surfaces of all fixed structures and the edge of the in-place mixture in all courses at transverse joints and longitudinal joints shall be given a uniform but not excessive coating of liquid asphalt or emulsified asphalt before placing the adjoining mixture.

E Compaction Operations

After being spread, each course shall be compacted to the required density. The rollers shall, as practicable, be operated continuously so all areas are thoroughly compacted to the required density. When not operating, the rollers shall not stand on the uncompacted mixture or newly rolled pavement having a surface temperature exceeding 60°C [**140°F**]. Rolling with steel-wheeled rollers shall be discontinued if it produces excessive crushing or pulverizing of the aggregate or displacement of the mixture.

To prevent adhesion of the mixture to the steel roller wheels, the contact surfaces of the wheels shall be kept properly moistened using water or a water solution containing small quantities of a detergent or other approved material.

To secure a true surface, variations such as depressions or high areas, which may develop during rolling operations, and lean, fat or segregated areas shall be corrected by removing and replacing the material in the defective area. All such corrections shall be accomplished as directed by the Engineer at no expense to the Department.

When mixtures are spread by a motor grader, pneumatic-tired rollers shall compact the mixture simultaneously with the spreading operation.

F Construction Joints

Joints shall be thoroughly compacted to produce a neat, tightly bonded joint that meets surface tolerances. Both transverse and longitudinal joints are subject to density requirements as outlined in Section 2360.6 Pavement Density.

F1 Transverse Joints

A transverse joint (full paver width at right angles to the centerline) shall be constructed when mixture placement operations are suspended. The forward end of the freshly laid strip shall be thoroughly compacted by rolling before the mixture has cooled. When work is resumed, the end shall be cut vertically for the full depth of the layer unless a formed edge is constructed as approved by the Engineer.

F2 Longitudinal Joints

Longitudinal joints between strips shall be parallel to the centerline. In multiple lift construction, the longitudinal joints between strips in each lift shall be constructed not less than 150 mm [**6 inches**] measured transversely from the longitudinal joints in the previously placed lift. When the wearing course is constructed in an even number of strips, one longitudinal joint shall be on the centerline of the road. When it is constructed in an odd number of strips, the centerline of one strip shall be on the centerline of the road, provided that no joint is located in the wheel path area of a traffic lane. Longitudinal joints in multiple lift construction over Portland cement concrete pavements may be aligned directly over the concrete pavement longitudinal joints at the discretion of the Engineer.

At longitudinal joints formed by placing multiple strips, the adjoining surface being laid shall, after final compacting, be slightly higher (but not to exceed 3 mm [**1/8 inch**]) than the previously placed strip. When constructing a strip adjoining a previously placed strip or a concrete pavement, any fresh mixture that overlaps a previously placed strip or pavement shall be removed (to the longitudinal joint line) before any rolling is done.

G Asphalt Mixture Production (FOB Department Trucks)

For asphalt mixture production, the Contractor shall, in addition to the asphalt mixture required on the Project, produce and deliver asphalt mixture to the Department. The mixture shall be the mixture being produced and shall be loaded on Department furnished trucks at the mixing plant at a time agreed on by the Engineer and Contractor. The Engineer will notify the Contractor of the total quantity of mixture desired not less than 2 weeks prior to completion of the wearing course construction. The Engineer will not accept the asphalt mixture if it is inappropriate for the Department's intended use.

H Small Quantity HMA Paving

Unless otherwise indicated in the Special Provisions, the following provision for a small quantity of asphalt mixture shall apply.

A Mixture Design Report is not required for planned project quantities less than 191,200 m^2 mm [**9,000 square yard inches [4,500 square yards per 2 inch thickness, etc**]) or 450 metric tons [**500 tons**]. However, the Contractor shall verify in writing the asphalt mixture delivered to the project meets the requirements of Table 2360.3-B2a and Table 2360.3B2b. The Department will obtain samples, as determined by the Engineer, to verify mixture requirements. These results will be used for material acceptance. Acceptance of material will be in accordance with the criteria outlined in Section 2360.4L1, L2, L3, and L8.

2360.6 PAVEMENT DENSITY

A General

All pavements will be compacted in accordance with the Maximum Density Method unless otherwise specified in the Contract special provisions or as noted in Section 2360.6C.

B Maximum Density Method

All courses or layers of plant mixed asphalt mixtures for which the Maximum Density Method is used shall be compacted to a density not less than the percentage shown in the Table of Required Density, Table 2360.6-B2, for the applicable mixture and course.

B1 Maximum Density Determination

The Density requirements listed in Table 2360.6B2 are percent of maximum specific gravity (G_{mm}) based on the individual lot. The Maximum specific gravity value used to calculate the percentage density for the lot shall be the average value obtained from the maximum gravity results from production tests taken during that days paving. If only one or two maximum specific gravity values were obtained that day, then the moving average value (at that test point) shall be used. If three or more maximum specific gravity values are obtained that day, then the average of those tests alone shall be used as indicated above.

B1a Pavement Density Determination

The density of each lot shall be expressed as a percentage of the maximum specific gravity (% G_{mm}) obtained by dividing the average bulk specific gravity for the lot by the maximum specific gravity multiplied by 100, (maximum specific gravity basis is the average G_{mm} of QC tests done on the day that the individual lot was paved as described above). Determination of the bulk specific gravity of the cores shall be in accordance with AASHTO T-166, Mn/DOT modified. For coarse graded mixtures the Engineer may require determination of bulk specific gravity of the cores be in accordance with ASTM D6752 Mn/DOT modified (Corelok). Both the Contractor and Mn/DOT shall use the same test method to determine bulk specific gravity. The determination of coarse and fine graded mixtures will be based on the percentage of material passing the 2.365 mm sieve [**#8**] as defined in Table 2360.3-B2c.

Compaction operations shall be completed within 8 hours of mixture placement and before core samples are obtained for density determination. Only pneumatic tired or static steel rollers are permitted for any compactive effort performed between 6 and 8 hours after mixture placement.

Compacted mixtures represented by samples or tests having deficient densities shall not be re-rolled. The Contractor shall not operate below the specified minimum density on a continuing basis. A continual basis shall be defined as all lots in a day’s production failing to meet minimum density or more than 50% of lots on multiple days which fail to meet minimum density requirements. Production shall be stopped until the source of the problem is determined and corrective action is taken to bring the work into compliance with specified minimum required density.

B2 Required Density

Minimum density requirements for both gyratory (SP) and Marshall designed mixtures are listed in Table 2360.6-B2.

Unless otherwise indicated in the Plans or Special Provisions, shoulders wider than 1.8 meters [**6 feet**] paved shall be compacted by the Maximum Density Method. When shoulders are required to be compacted by the Maximum Density Method and are paved in a separate operation or have a different required minimum density than the driving lane, the lot tonnage placed on the shoulder shall be delineated in separate lots from the driving lanes for the day paving was conducted.

Unless otherwise indicated in the Plans or Special Provisions a narrow shoulder, 1.8 meter [**6 feet**] or less wide, that is paved in the same pass as a driving lane or that is paved separately will be compacted by the Ordinary Compaction Method. Mixture compacted under Ordinary Compaction is excluded from lot density requirements and that tonnage is also excluded from incentive/disincentive payment.

If the Plans or Special Provisions indicate a narrow shoulder is to be compacted by the Maximum Density Method, the minimum required density is listed in Table 2360.6-B2. If the minimum required density of the shoulder is different than the driving lane, the tonnage placed on the shoulder shall be delineated in separate lots from the driving lane.

Echelon paving (two pavers operating next to each other in adjacent lanes) shall be considered separate operations.

Table 2360.6-B2
Required Minimum Lot Density

	SP Wear and All MV and LV Mixtures (1)(2)	**SP Nonwear (1)(2)**	**SP Shoulders (1)(2)**	
			Designed at 3% voids	Designed at 4% voids
% Gmm	92.0	93.0	93.0	92.0

1) Minimum reduced by one percent on the first lift constructed over PCC pavements.
2) Minimum reduced by one percent for the first lift constructed on aggregate base (mainline and shoulder), reclaimed or cold inplace recycled base courses and first lift of an overlay on a roadway with a 6.35 metric ton [**7 ton**] or less spring load restriction (roadway includes shoulders).

B2a Lots & Core Locations

Table 2360.6-B2a
Lot Determination

Daily Production		Lots
Metric (ton)	[**English (Ton)**]	
270* – 545	[**300* – 600**] 1	
546 – 910	[**601 – 1,000**] 2	
911 – 1,455	[**1,001 – 1,600**] 3	
1,456 – 3,275	[**1,601 – 3,600**] 4	
3,276 – 4,545	[**3,601 – 5,000**] 5	
4,546 +	[**5,001 +**] 6	

*When mix production is less than 270 metric tons [**300 tons**], establish 1st lot when accumulative tonnage exceeds 270 metric tons [**300 tons**].

Divide the days production into equal lots as shown in Table 2360.6-B2a. The Engineer may require additional density lots be established to isolate areas affected by equipment malfunction/breakdown, heavy rain, or other factors that may affect the normal compaction operations. Obtain three cores in each lot. Two cores will be taken from random locations selected by the Engineer. The third core, a companion core, shall be taken within 0.3 meters [**1 foot**] longitudinally from either of the first two cores. The companion cores shall be given to the Department Street Inspector immediately upon completion of coring and sawing. The random locations will be determined by the Engineer using statistically derived stratified random number tables or other approved methods of random number generation. These will also be used for partial lots. Both transverse and longitudinal joints are subject to maximum density requirements. If the random core location falls on an unsupported joint, at the time of compaction, (the edge of the mat being placed does not butt up against another mat, pavement surface, etc.) cut the core with the outer edge of the core barrel 0.3 meters [**1 foot**] away (laterally) from the edge of the top of the mat (joint). If the random core location falls on a confined joint (edge of the mat being placed butts up against another mat, pavement surface, curb and gutter, or fixed face), cut with the outer edge of the core barrel 150 mm ± 12.5 mm [**6 inches ± 0.5 inch**] from the edge of the top of the mat (ex. center of 100 mm [**4 inch**] core barrel 200 mm ± 12.5 mm [**8 ± 0.5 inches**] from the edge of the top of the mat). Cores will not be taken within 300 mm [**1 foot**] of any unsupported edge The Contractor shall be responsible for maintenance of traffic, coring, patching the core holes, and sawing the cores if necessary to the proper thickness prior to density testing.

B3 Core Testing

Cores will be taken and tested by the Contractor. Core locations will be determined and marked by the Engineer. The Contractor shall schedule the approximate time of testing during normal project work hours so that the Engineer may observe and record the saturated surface dry and immersed weight of the cores.

Density determination will be made by the end of the next working day after placement and compaction. If multiple layers are placed in a single day, cores shall be sawn and separated for each layer, tested and reported by the end of the next working day.

The Contractor will cut pavement samples from the completed work with power equipment, and restore the surface by the end of the next working day with new, well compacted mixture without additional compensation. Failure to restore the surface within 24 hours of coring shall subject the Contractor to a fine of $100 per working day, per lot, until the core holes are restored. Cores shall be cut using a 100 mm [**4 inch**] minimum outer diameter coring device. All samples shall be marked with the lot number and core number or letter. The cores shall be transported to the laboratory as soon as possible to prevent damage due to improper handling or exposure to heat. These companion cores may be tested by the Inspector on Department scales or transported to the Department's Field Laboratory or District Materials Laboratory.

Measure each core three times for thickness prior to saw cutting, report the average lift thickness on the core sheet. These average thicknesses will contribute to thickness compliance as described in Section 2360.7A

If the Department companion core test result for bulk specific gravity (G_{mb}) deviates beyond the allowable tolerance of 0.030, substitute Department companion result for Contractor's core result and then average the Department result with the non-companion result for the lot density acceptance. If, through analysis of data, it is determined there is a bias in the test results, the Engineer will determine which results are appropriate and shall govern.

If the G_{mb} tolerance fails in more than 2 lots in a day of either consistently high or low differences between the companion cores then an investigation to determine the source of errors shall be conducted. Companion cores samples shall be increased to two per lot and tested until investigation is complete and tolerances are met.

The Engineer may allow recoring of a sample only when the core has been damaged through no fault of the Contractor, either during the coring process or in transit to the laboratory.

B4 Maximum Density Acceptance and Payment Schedule

The density of compacted mixture shall be accepted by pavement cores on a lot basis.

The Contractor's cores will be used for acceptance if the determined bulk specific gravity G_{mb} from AASHTO T-166, Mn/DOT modified or ASTM D6752 Mn/DOT modified (Corelok) is within $\pm$ 0.030 of the state companion G_{mb} value. Payment for lot densities of compacted mixture shall be determined from Table 2360.6-B4 or 2360.6-B4A. Incentive and disincentive payments are for both wearing and non-wearing courses.

When the density requirement has been reduced by one percent, per Table 2360.6-B2, footnote 1 & 2, payment adjustments for lot densities will be made as specified in Table 2360.6-B4A. Incentive payments are excluded when the minimum density has been reduced. However, at the Contractors request and with approval of the Engineer, the reduced density requirement may be waived and density evaluated under Table 2360.6-B4, including incentives, for first lift constructed on aggregate base, reclaimed or cold inplace recycled base courses and first lift of an overlay on a roadway with a 6.35 metric ton [**7 ton**] or less spring load restriction (reduced density shall not be waived for the first lift constructed on PCC pavements). The request and approval shall be made after the first days paving and before the third days paving begins. Once the request has been approved, evaluation of density will be in accordance with Table 2360.6-B2 (excluding footnote 2) and Table 2360.6-B4, and will remain in effect for the duration of mixture placement on that lift. The Contractor will also be responsible for compliance with any construction requirements on subsequent lifts.

Table 2360.6-B4
Payment Schedule for Maximum Density

Percent of Max Specific Gravity (2) SP Wear All MV & LV , SP Shld (4% Void)	Percent of Max Specific Gravity (2) SP Non-Wear SP Shoulders (3% Void)	Percent Payment
93.6 and above	94.6 and above	104 (3)
93.1 - 93.5	94.1 - 94.5	102 (3)
92.0 - 93.0	93.0 - 94.0	100
91.0 - 91.9	92.0- 92.9	98
90.5 - 90.9	91.5 - 91.9	95
90.0 - 90.4	91.0 - 91.4	91
89.5 - 89.9	90.5 - 90.9	85
89.0 - 89.4	90.0 - 90.4	70
Less than 89.0 (4) Less	than 90.0	(4)

Table 2360.6-B4A (1)
1% Reduced Table

Percent of Max Specific Gravity (2) SP Wear All MV & LV , SP Shld (4% Void)	Percent of Max Specific Gravity (2) SP Non-Wear SP Shoulders (3% Void)	Percent Payment
91.0 and above	92.0 and above	100
90.0 - 90.9	91.0- 91.9	98
89.7 - 89.9	90.5 - 90.9	95
89.4 - 89.6	90.0 - 90.4	91
89.2 - 89.3	89.5 –89.9	85
89.0 - 89.1	89.0 - 89.4	70
Less than 89.0 (4) Less	than 89.0	(4)

(1) Minimum reduced by one percent for the first lift constructed on aggregate base (mainline and shoulder), reclaimed or cold inplace recycled base courses and first lift of an overlay on a roadway with a 6.35 metric ton [**7 ton**] or less spring load restriction (roadway includes shoulders). Minimum reduced by one percent on the first lift constructed on PCC pavements (reduced density cannot be waived).

(2) In calculating the percent of maximum specific gravity, report to the nearest tenth.

(3) The payment in this portion of the specification shall apply only if the day's weighted average individual production air voids are within - 0.5 percent of the target air void value. The weighted average air voids shall be based on all the mixture production tests (2360.4e) for the corresponding day and shall be weighted by the tons the corresponding test represents.

(4) The HMA material represented by the lot shall be paid at a 70% pay factor, unless a single core density is less than 87.0% of the maximum specific gravity (Gmm). If a single core density is less than 87.0% of Gmm, the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. Reduced payment will be 50 percent of the Contract bid price. If the mixture is to be removed and replaced, the Contractor at his expense will remove and replace with mixture that meets the density requirement. The limits of the area to be removed and replaced will be determined by additional core samples. These additional core samples shall be taken at the same offset from centerline as the original core; unless the original low density core

was taken within 0.45 m [**1.5 feet**] of an edge of the paver pass. In that case, the additional cores shall be taken 0.45 m [**1.5 feet**] from the edge of the paver pass. The densities shall be determined at 15 m [**50 foot**] intervals, both ahead and back of the point of unacceptable core density (less than 87.0% of Gmm), until a point of acceptable core density (87.0% of Gmm or greater) is found. If the incremental core density testing extends into a previously accepted lot, removal of the unacceptable material will be required; however, the results of these tests shall not be used to recalculate the previously accepted lot density. All costs incurred from additional coring and testing, resulting from unacceptable core density, will be paid by the Contractor. The unacceptable pavement area is to be computed as the product of the longitudinal limits so determined by the 15 m [**50 foot**] cores and the full width of the paver pass, laying in the traffic lane or lanes. Shoulders shall be exempt from this calculation unless density failure occurred in the shoulder area.

After the unacceptable material (core density less than 87.0% of Gmm) has been removed and replaced, the density of the replacement material will be determined by the average of two cores. Payment for the replacement material will be in accordance with Tables 2360.6-B4 or 2360.6-B4A, whichever applies. There will be no payment for the material removed. The remainder of the original lot shall have a 70% pay factor.

C Ordinary Compaction Method

Ordinary compaction shall be used for layers identified in the typical sections with a minimum planned thickness of less than 40 mm [**1 1/2 inches**], thin lift leveling, wedging layers, patching layers, driveways, areas which cannot be compacted with standard highway construction equipment. Unless otherwise indicated in the Plans or Special Provisions recreational trails shall also be compacted by ordinary compaction. The ordinary compaction method shall not be used on mainline, ramp, or loop paving, unless otherwise designated in the plans or special provisions. When density is evaluated by the ordinary compaction method a control strip shall be used to establish a rolling pattern. This shall be used by the Contractor for the compaction of the asphalt mixture for the layer on which the control strip is constructed, or until a new control strip is constructed. The control strip requirement may be waived, by the Engineer, in small localized areas or other areas not conducive to its establishment.

A control strip shall be constructed at the beginning of the work on each lift of each course. Each control strip shall have an area of at least 330 m^2 [**395 square yards**] and shall be of the same thickness as the lift it represents. The subgrade or pavement course upon which a control strip is to be constructed shall have the prior approval of the Engineer. The control strips shall remain in place and become part of the completed work.

The materials used in the construction of the control strips shall conform to the specified requirements for the course. The materials used in the control strip shall be from the same source and of the same type as the materials used in the remainder of the course that the control strip represents.

The equipment used in the construction of the control strips shall be approved by the Engineer and shall be the same type and mass used on the remainder of the pavement course represented by the control strip. A minimum of two rollers shall be required. A rolling pattern shall be established for each roller. A pneumatic-tired roller shall be available for compaction operations within 24 hours after request by the Engineer. The final rolling shall be performed with a tandem steel-wheeled roller. Areas that are inaccessible to the conventional type rolling equipment shall be compacted to the required density by using trench rollers or mechanical tampers.

Construction of the control strips will be as directed by the Engineer. Compaction shall commence as soon as possible after the mixture has been spread to the desired thickness and shall continue until no appreciable increase in density can be obtained by additional roller's coverages. Densities will be determined by means of a portable nuclear testing device or suitable approved alternate and a growth curve shall be developed to determine the optimum rolling pattern. The Contractor shall furnish documentation of the growth curve to the Engineer.

To determine when no appreciable increase in density can be obtained, two test points shall be established in the control strip on a random basis and the density at each point shall be measured by a portable nuclear device or suitable approved alternate after each roller pass. Rolling shall be suspended when testing shows either a decline of more than 2% of the maximum specific gravity or when additional roller passes fail to increase the density.

After said testing is accomplished, rolling on the remainder of that course shall be done in accordance with the pattern developed in the test strip for that roller. A separate rolling pattern and time interval shall be established for each roller.

A new control strip shall be ordered by the Engineer when:

(a) A change in the JMF is made, or
(b) A change in the source of material is made or a change in the material from the same source is observed.

A new control strip may be ordered by the Engineer or requested by the Contractor when:

(a) Ten days of production have been accepted without construction of a new control strip, or
(b) There are other reasons to believe that a control strip density is not representative of the HMA mixture being placed.

The nuclear testing device shall be furnished and operated by the Contractor. The furnishing of the testing device and the operator will be considered incidental to the furnishing and placement of the HMA mixture and shall not be compensated for separately. The device shall be calibrated according to procedures described in the Mn/DOT Bituminous Manual.

Each course shall be uniformly compacted until there is no further evidence of consolidation and all roller marks are eliminated. When this method is employed, and the quantity of mixture placed by the paver exceeds 100 metric tons [**110 tons**] per hour, at least two rollers are required for compacting the mixture placed by each paver.

C1 Rollers

The following requirements for rollers apply only when compaction is obtained by the ordinary compaction method.

C2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be self-propelled and has a minimum total mass of 7.3 metric tons [**8 tons**], or as otherwise specified in the Contract. When vibratory rollers are used, they shall produce 45 kN per meter [**3,085 lbf per foot**] of width. The frequency should be at least 2400 vpm and amplitude setting low. The roller shall be capable of reversing without backlash and shall be equipped with spray attachments for moistening all rollers on both sets of wheels.

C3 Pneumatic-Tired Rollers

The pneumatic-tired roller shall have a compacting width of 1.5 m [**5 feet**] or more. It shall be so constructed that the gross wheel load force shall be a minimum of 13 kN [**3,000 pounds**] per wheel for LV and MV mixtures and SP Level 2-3 mixtures and 22 kN [**5,000 pounds**] per wheel for SP Level 4-6 mixtures and can be varied as directed by the Engineer. The tire arrangement shall be such that full compaction will be obtained over the full width with each pass of the roller.

The roller may be self propelled or provided with suitable tractive equipment, unless otherwise specified in the Contract. If more than one roller is propelled by a single tractive unit, then that combination will be counted as a single roller unit.

C3a Vibratory Pneumatic-Tired Rollers

Vibratory pneumatic-tired rollers shall be self-propelled and have a minimum total mass of 7.3 metric tons [**8 tons**], or as otherwise specified in the Contract. The compacting width shall be 1.5 m [**5 feet**] or more. The tire arrangement shall be such that full compaction will be obtained over the full width with each pass of the roller.

C4 Trench Rollers

Trench rollers shall be self propelled and have a mass of not less than 4 400 kg per meter [**2,960 pounds per foot**] of width.

C5 Mixture Temperature Controls

If compaction is obtained by the ordinary compaction method, the minimum laydown temperature in all courses (as measured behind the paver or spreading machine) of the asphalt mixture shall be in accordance with the temperature requirements of Table 2360.6-C5. Unless directed by the Engineer in writing, no paving is allowed under the Ordinary Compaction Method when the air temperature is below 0°C [**32°F**].

Table 2360.6-C5
Mixture Temperature Control

Air Temperature	**Compacted Mat Thickness, mm (A)**			
°C [**°F**]	25 mm [**1 inch**]	40 mm [**1-1/2 inch**]	50 mm [**2 inch**] >	_75 mm [**3 inch**]
+0-5 [**32-40**] --		129 (B) [**265**] 12	4 [**255**] 12	1 [**250**]
+ 6-10 [**41-50**] 13	0 (B) [**270**] 12	7 [**260**] 12	1 [**250**] 11	8 [**245**]
+ 11-15 [**51-60**] 12	7 (B) [**260**] 12	4 [**255**] 11	8 [**245**] 11	5 [**240**]
+ 16-21 [**61-70**] 1	21(B) [**250**] 11	8 [**245**] 11	5 [**240**] 11	3 [**235**]
+ 22-27 [**71-80**] 11	8 [**245**] 11	5 [**240**] 11	3 [**235**] 11	3 [**235**]
+ 28-32 [**81-90**] 11	3 [**235**] 11	0 [**230**] 11	0 [**230**] 11	0 [**230**]
+ 33 [**91+**] 11	0 [**230**] 11	0 [**230**] 11	0 [**230**] 10	7 [**225**]

(A) Based on approved or specified compacted lift thickness.
(B) A minimum of one pneumatic-tire roller shall be used for intermediate rolling unless otherwise directed by the Engineer. The Engineer may specify or modify in writing (with concurrence from the Department Bituminous Engineer) a minimum laydown temperature.

2360.7 THICKNESS AND SURFACE SMOOTHNESS REQUIREMENTS

A Thickness

After compaction the thickness of each lift shall be within a tolerance of 6 mm [**1/4 inch**] of the thickness shown in the Plans, except that, if automatic grade controls are used, this thickness requirement will not apply to the first lift placed. This thickness requirement will not apply to a leveling lift whether or not automatic grade controls are required. The Engineer may require removal and replacement, at the Contractor’s expense, of any part of any lift that is constructed to less than the minimum required thickness.

Cores taken for density determination shall be measured for thickness also. Each core shall be measured 3 times for thickness prior to sawing. Report the average of these three measurements. Each lot’s average core thickness shall be documented and submitted to the Engineer. If the average of the two Contractor cores exceed the specified tolerance, an additional two cores may be taken in the lot in question. The average of all core thickness measurements per day per lift will be used to determine daily compliance with thickness specifications.

On that portion of any lift constructed to more than the maximum permissible thickness, the materials used in the excess mixture above that required to construct that portion of the lift to the Plan thickness plus

6 mm [**1/4 inch**] may be excluded from the pay quantities and at the discretion of the Engineer and at the Contractor's expense may be required to be removed and replaced.

B Surface Requirements

After compaction, the finished surface of each lift shall be reasonably free of segregated, open and torn sections, and shall be smooth and true to the grade and cross section shown on the Plans with the following tolerances:

(1) Where a leveling lift is specified, it shall be constructed to within a tolerance of 15 mm [**1/2 inch**] of the elevations and grades established by the Engineer. This requirement shall also apply to the first lift placed other than leveling when automatic controls are used.

(2) The surface of the final two lifts placed shall show no variation greater than 6 mm [**1/4 inch**] from the edge of a 3 m [**10 foot**] straightedge laid parallel to or at right angles to the centerline. Shoulder surfacing and surfacing on temporary connections and bypasses shall show no variations greater than 6 mm [**1/4 inch**] from the edge of a 3 m [**10 foot**] straightedge laid parallel to the centerline.

(3) After final compaction, all final lift asphalt wearing surfaces adjacent to concrete pavements shall be slightly higher (but not to exceed 6 mm [**1/4 inch**] than the concrete surface.

After final compaction, all asphalt surfaces adjacent to gutters, manholes, pavement headers, or other fixed structures shall be slightly higher (but not to exceed 6 mm [**1/4 inch**] than the surface of the structure.

(4) Transverse joints (construction joints), at the beginning and end of a project, at paving exceptions, or caused by suspension of daily paving operations, shall show no variation greater than 6 mm [**1/4 inch**] from the edge of a 3 m [**10 foot**] straightedge centered longitudinally across the transverse joint. The Engineer may require correction by diamond grinding when material is placed outside the above-described limitations.

(5) The transverse slope of the surface of each lift, exclusive of the shoulder wearing lift, shall not vary from the slope shown in the Plans by more than 0.4 percent.

(6) The distance between the edge of each lift and the established centerline shall be no less than the Plan distance nor more than 75 mm [**3 inches**] greater than the Plan distance. In addition, the edge alignment of the wearing lift on tangent sections and on curve sections of 3 degrees or less shall not deviate from the established alignment by more than 25 mm [**1 inch**] in any 7.5 m [**25 foot**] section.

(7) The finished surface of each lift shall be reasonably free of segregated and open and torn sections.

Any material placed outside the above described limitations shall be removed and replaced after being cut or sawed at no expense to the Department or with the approval of the Engineer, allowed to remain inplace at a reduced cost calculated at $12 per square meter [**$10 per square yard**].

C Pavement Smoothness Specification – IRI (International Roughness Index)

C1 General

Pavement smoothness will be evaluated on the final mainline pavement surface using an Inertial Profiler (IP) and the International Roughness Index (IRI). Unless otherwise authorized by the Engineer, all smoothness testing shall be performed in the presence of the Engineer. The Engineer and the Contractor shall mutually agree upon scheduling of smoothness testing so that testing can be observed. Any testing performed without the Engineer's presence, unless otherwise authorized, may be ordered retested at the Contractor's expense.

The following Table 2360.7-A (IRI) shows pavement surfaces that are excluded from smoothness testing but subject to 2360.7B surface requirements.

Table 2360.7 – A (IRI)
Testing Exclusions

7.62 m **[25 foot]** feet either side of obstructions such as manholes, water supply castings, etc.*
Ramps, Loops, Climbing lanes
Side Streets, Side Connections
Turn Lanes, Storage Lanes, Crossovers, Bypass Lanes
Shoulders
Intersections constructed under traffic – Begin and end the exclusion 30.5m [**100 feet**] from the intersection radius
Sections less than 7.62 m **[25 foot]** in length
Acceleration, Deceleration Lanes
Projects less than 300m [**1000 feet**] in length
Mainline paving where the normally posted regulatory speed is less than or equal to 70 km/hr [**45 miles per hour**]
Begin the exclusion at the sign
Single lift overlays over concrete

*Mainline shall be included in profiling if obstructions are located in auxiliary or parking lanes

C1A Smoothness Requirements

Pavement smoothness requirements will be evaluated by the International Roughness Index (IRI) Equation A, Equation B, or Equation C. The pavement smoothness Equation will be identified in the Special Provisions of the proposal. Location of bumps and/or dips and magnitude will be based on California Test Method 526.

C2 Measurement

Smoothness will be measured with an IP, which produces both an IRI value and a profilogram (profile trace of the surface tested). The IP shall conform to the Class 1 requirements of ASTM E950-94 and must be certified according to the most recent procedure on file in the Bituminous Office. For pavement evaluation, one pass will be made in the right wheel path of each traffic lane. The IP shall be run in the direction the traffic will be moving. Each lane will be tested and evaluated separately. The Engineer will determine the length in kilometers [**miles**] for each mainline traffic lane. The IP shall be operated at the optimum speed as defined by the manufacturer.

C3 Smoothness testing

The Contractor shall furnish a properly calibrated, documented, and MnDOT certified IP. The IP shall be equipped with automatic data reduction capabilities. Computer programs used to calculate the IRI statistic from a longitudinal roadway profile shall follow the procedure developed by the World Bank for a quarter-car simulation as described in NCHRP report 228.

Mn/DOT certification documentation shall be provided to the Engineer on the first day the IP is used on the project. IP settings are on file in the Bituminous Office. The Contractor shall furnish a competent operator, trained in the operation of the IP and evaluation of both California Test Method 526 and the International Roughness Index.

The Contractor shall remove all objects and foreign material on the pavement surface prior to surface evaluation by power brooming.

The pavement surface will be divided into sections which represent continuous placement. A section will terminate 7.62 m **[25 foot]** before a bridge approach panel, bridge surface, manhole or similar interruption. In the final pavement evaluation, a day's work joint will be included in the trace with no special consideration. A section will be separated into segments of 0.1 km **[0.1 mi]**. A segment will be in one traffic lane only.

An IRI value shall be computed for each segment of 7.62 m **[25 foot]**or more. The IRI value will include the 7.62 m **[25 foot]** at the ends of the section only when the Contractor is responsible for the adjoining surface.

End of run areas not included in the IRI value and any sections of pavement less than 7.62 m **[25 foot]** in length shall be checked longitudinally with a 3.028 m **[10 ft]** straight edge and the surface shall not deviate from a straight line by more than 6 mm in 3.028 m **[1/4 inch in 10 ft]**. Transverse joints shall be evaluated by centering the straightedge longitudinally across the transverse joint.

The Contractor shall submit the graphical trace, a summary of the bump(s)/dip(s) locations, the magnitude of the bump(s)/dip(s) and each segment IRI value on the same day as the profiling was conducted.

The Contractor shall submit a final spreadsheet summary of the smoothness data to the Engineer within five calendar days after all mainline pavement placement. The summary shall be signed by the Contractor. The spreadsheet summary shall be in tabular form, with each 0.1 km **[0.1 mile]** segment occupying a row. Each row shall include the beginning and ending station for the segment, the length of the segment, the final IRI value for the segment~~,~~ the IRI based incentive/disincentive in dollars for the segment, and the deductions for bump(s)/dip(s) in dollars for the segment. Each continuous run will occupy a separate table and each table will have a header that includes the following: the project number, the roadway number or designation, a lane designation, the mix type of the final lift, the PG binder of the final lift, the date of the final smoothness runs, and the beginning and ending station of the continuous run. The following information shall be included at the bottom of each summary: a subtotal for the IRI based incentive/disincentive, a subtotal for the bump deductions, and a total for incentive/disincentive for both IRI values and bumps. Software to summarize the data is available from the Mn/DOT Bituminous Office at www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp.

The Contractor will be responsible for all traffic control associated with the smoothness testing and any corrective action (when applicable) that is required of the final pavement surface.

C3A Retesting

The Engineer may require any portion or the total project to be retested if the results are questioned. This includes both IRI values and bump/dip locations. The Engineer will decide whether Mn/DOT, an independent testing firm (ITF), or the Contractor will retest the roadway surface.

If the retested IRI values differ by more than 10% from the original IRI values, the retested values will be used as the basis for acceptance and any incentive/disincentive payments. In addition, bump/dip locations as shown by the retest will replace the original results.

If the Engineer directs the Contractor or an independent testing firm to perform retesting and the original results are found to be accurate, the Department will pay the Contractor or the independent testing firm $62.14 per lane km [$100 per lane mile] that is retested, with a minimum charge of $500.00. The Contractor will be responsible for any costs associated with retesting if the original values differ by more than 10% from the retested values.

C4 IRI Values

The IP shall be equipped with automatic data reduction capabilities for determining the IRI values. An IRI value shall be calculated for each segment of the final pavement surface. The IRI values shall be determined by following NCHRP report 228. The IRI values shall be reported in units of m per km **[inches per mile]**.
Both m per km and inches per mile shall be reported with two digits right of the decimal. Follow Mn/DOT rounding procedures per the Bituminous Manual section 5-693.730.

When there is a segment equal to or less than 76.2 m **[250 ft]** in length at the end of a lane of paving, the IRI value for that segment shall be mathematically weighted and added to and included in the evaluation of the adjacent segment. Segments greater than 76.2 m **[250 ft]** in length will be evaluated individually.

C4a Bumps and Dips – IRI Equation A and IRI Equation B

Bump/dip location will be determined in accordance with California Method 526. Bumps and dips equal to or exceeding 10.2 mm in a 7.62 m **[0.4 inch in a 25 ft]** span shall be identified separately. When the profile trace shows a successive, uninterrupted bump, dip; or dip, bump combination (up to a maximum of 3 alternating trace deviations that relate to one bump or dip on the roadway), identify and evaluate these occurrences as one event.

The Contractor shall correct, by diamond grinding, all areas represented by bumps or dips of 10.2 mm **[0.4 inch]** or more as measured by California Test Method 526. However, the Engineer may allow bumps or dips of 10.2 mm to 15.2 mm **[0.4 inches to 0.6 inches]** in a 7.62 m **[25 foot]** span to be left uncorrected, and in such case, the contractor will be assessed a price deduct as specified in section C6 (“Payment”) of this special provision.

Corrected dips or bumps will be considered satisfactory when the profilogram shows the deviations are less than 10.2 mm in a 7.62 m **[0.4 inch in a 25 foot]** span.

C4b Bumps and Dips – IRI Equation C

Bump/dip location will be determined in accordance with California Method 526. Bumps and dips equal to or exceeding 12.7 mm in a 7.62 m **[0.5 inch in a 25 ft]** span shall be identified separately. When the profile trace shows a successive, uninterrupted bump, dip; or dip, bump combination (up to a maximum of 3 alternating trace deviations that relate to one bump or dip on the roadway), identify and evaluate these occurrences as one event.

The Contractor shall correct, by diamond grinding, all areas represented by bumps or dips of 12.7 mm **[0.5 inch]** or more as measured by California Test Method 526. However, the Engineer may allow bumps or dips of 12.7 mm to 17.8 mm **[0.5 inches to 0.7 inches]** in a 7.62 m **[25 foot]** span to be left uncorrected, and in such case, the contractor will be assessed a price deduct as specified in section C6 (“Payment”) of this special provision.

Corrected dips or bumps will be considered satisfactory when the profilogram shows the deviations are less than 12.7 mm in a 7.62 m **[0.5 inch in a 25 foot]** span.

C5 Surface Correction

Unless otherwise approved by the Engineer, corrective work shall be by diamond grinding. Other methods may include; overlaying the area, or replacing the area by milling and inlaying. The Engineer shall approve of the Contractor’s method of correcting segment(s) prior to the Contractor starting corrective work. Any corrective actions by milling and inlay or overlay shall meet the specifications for ride quality over the entire length of the correction, including the first and last 7.62 m **[25 foot]**. Bumps or dips in excess of 10.2 mm [**0.4 inches]** where evaluation is by Equation A or B or bumps or dips in excess of 12.7 mm **[0.5 inch]** where evaluation is by Equation C that are located at transverse joints at areas of corrective actions utilizing overlay or milling and inlay, shall be removed by diamond grinding. The Contractor shall notify the Engineer prior to commencement of the corrective action. If the surface is corrected by overlay, inlay or replacement, the surface correction shall begin and end with a transverse saw cut. Surface corrections shall be made prior to placing permanent pavement markings. In the event that permanent pavement marking are damaged or destroyed during surface correction activities, they will be replaced at no cost to the Agency.

When pavement smoothness evaluation by Equation A is specified the Engineer may require that the Contractor, at no expense to the Department, correct segments with an IRI greater than 1.03 m per km **[65 inches/mile] or the** Engineer may assess a $560 per 0.1 km **[$900 per 0.1 mile]** penalty in lieu of requiring corrective work.

When pavement smoothness evaluation by Equation B is specified the Engineer may require that the Contractor, at no expense to the Department, correct segments with an IRI greater than 1.18 m per km **[75 inches/mile] or the** Engineer may assess a $420 per 0.1 km **[$675 per 0.1 mile]** penalty in lieu of requiring corrective work.

When pavement smoothness evaluation by Equation C is specified the Engineer may require that the Contractor, at no expense to the Department, correct segments with an IRI greater than 1.34 m per km **[85 inches/mile] or the** Engineer may assess a $280 per 0.1 km **[$450 per 0.1 mile]** penalty in lieu of requiring corrective work.

Bump, dip, and smoothness correction work shall be for the entire traffic lane width. Pavement cross slope shall be maintained through corrective areas.

All corrective work shall be subject to the approval of the Engineer. After all required corrective work is completed a final segment(s) IRI value and bump/dip tabulation shall be determined and submitted to the Engineer. Corrective work and re-evaluation shall be at the Contractor's expense.

Segments requiring grinding will be re-profiled within two working days of completion of grinding. Individual bumps/dips and segments requiring grinding shall be completed with 15 working days of notification.

C6 Payment

The cost of traffic control for certified smoothness testing and/or any corrective work is incidental to the cost of the Wear course mixture.

The Contractor may receive an incentive payment or be assessed a penalty based on the number of segments and the IRI value. The total ride incentive shall not exceed 10% of the total mix price for pavement smoothness evaluated under IRI Equation A, 5% of the total mix price for pavement smoothness evaluated under Equation B, or 5% of the total mix price for pavement smoothness evaluated under Equation C. Total mix shall be defined as **all** mixture placed on the project. Pay adjustments for incentives will only be based on the segment IRI value before any corrective work has been performed. Any segment that contains corrective action for IRI value or bumps is not eligible for incentive pay.

The Contractor will not receive a net incentive payment for ride if more than 25% of all density lots for the project fail to meet minimum density requirements.

For pavement smoothness evaluated under Equation A uncorrected bumps or dips greater than or equal to 10.2 mm **[0.4 inches]** in a 7.62 m **[25 foot]** span will be assessed a price deduction of $900 per event.

For pavement smoothness evaluated under Equation B uncorrected bumps or dips greater than or equal to 10.2 mm **[0.4 inches]** in a 7.62 m **[25 foot]** span will be assessed a price deduction of $675 per event.

For pavement smoothness evaluated under Equation C uncorrected deviations (bumps or dips) greater than or equal to 12.7 mm **[0.5 inches]** in a 7.62 m **[25 foot]** span will be assessed a price deduction of $450 per event.

Combinations of bumps and dips which arise from the same single bump or dip are considered to be one event, and shall be counted only once for the purposes of calculating price deductions. Typically, bump-dip-bump combinations, or dip-bump-dip combinations, that are confined to a 30 feet longitudinal segment are considered to be one event.

Bumps or dips resulting from a construction joint will be assessed a $900 penalty, regardless of the IRI Equation used for evaluation or pavement smoothness.

Incentive/disincentive payments will be based on the IRI determined for each segment and will be based on the following equations and criteria.

C6a IRI Equation A*

IRI m/km **[inches/mile]**	Ince	ntive/Disincentive $/0.1km **[$/0.1mile]**
< 0.47 m/km **[< 30 inches/mile]**		$249 **[$400]**
0.47 m/km to 1.03 m/km **[30 inches/mile to 65 inches/mile]**		$523 – (IRI x 584) **[$850 – (IRI x 15)]**
1.03 m/km **[> 65 inches/mile]**	-	$560 **[-$900]**

* Typically, 3-lift minimum construction

C6b IRI Equation B*

IRI m/km **[inches/mile]**	Ince	ntive/Disincentive $/0.1km **[$/0.1mile]**
< 0.52 m/km **[< 33 inches/mile]**		$168 **[$270]**
0.52 m/km to 1.18 m/km **[33 inches/mile to 75 inches/mile]**		$373 – (IRI x 395) **[$600 – (IRI x 10)]**
1.18 m/km **[> 75 inches/mile]**	-	$420 **[-$675]**

* Typically, 2-lift construction

C6c IRI Equation C*

IRI m/km **[inches/mile]**	Ince	ntive/Disincentive $/0.1km **[$/0.1mile]**
< 0.57 m/km **[< 36 inches/mile]**		$112 **[$180]**
0.57 m/km to 1.34 m/km **[36 inches/mile to 85 inches/mile]**		$258 – (IRI x 257) **[$414 – (IRI x 6.5)]**
1.34 m/km **[> 85 inches/mile]**	-	$280 **[-$450]**

* Typically, single lift construction

2360.8 METHOD OF MEASUREMENT

A Asphalt Mixture

Asphalt mixture of each type will be measured separately by mass, based on the total quantity of material hauled from the mixing plant, with no deductions being made for the asphalt materials.

B Blank

C Asphalt Mixtures Measured by the Square Meter [Square Yard] per Specified (mm [inch]) and for Mixtures Measured by the [Square Yard inch]

Asphalt mixture of each type and for each specific lift will be measured separately by area and by thickness on the basis of actual final dimensions placed. The constructed thickness shall meet tolerances set forth in Sections 2360.7A.

APPENDIX C1

State Test Case #3, Pennsylvania:

PA DOT SECTION 409AP

Airport Pavement for <60,000# AGW

409AP. SUPERPAVE ASPHALT CONCRETE, inclusive, and all other referenced parts of Pennsylvania Department of Transportation, standard Specifications for Road and Bridge Construction, Current Edition, Section 409, are applicable under this SECTION 409AP, except as modified herein.

Equivalent Terms for this Specification, and throughout application of Pennsylvania Department of Transportation, standard Specifications for Road and Bridge Construction, Current Edition, are listed below:

Materials and Testing Division (MTD), synonymous with Airport Owner

District Materials Engineer / Manager (DME/DMM), synonymous with Airport Owner

Representative, synonymous with Airport Owner

District Executive, synonymous with Airport Owner

District, synonymous with Airport Owner

Department, synonymous with Airport Owner

409AP.1 DESCRIPTION This work is the standard construction of plant-mixed HMA on a prepared surface using a volumetric mix design developed with the Superpave Gyratory Compactor, **Table 1**, **in accordance with these specifications and must conform to the lines, grades thicknesses and typical cross sections shown on the plans.. Each course must be constructed to the depth, typical section and elevation required by the plans and must be rolled, finished and approved before the placement of the next course. The materials and composition must meet the appropriate requirements of the Pa DOT Publication 408, except as modified herein.**

Table 1

Aircraft Gross Weight, (#)	**Gyration Level**	**Equivalent ESALs (million)**
< 12,500	**50**	**< 0.3**
12,500 to < 60,000	**75**	**0.3 to < 3.0**

409AP.2(a)1 Virgin Mix or **Surface** Mix Containing 5% to 15% RAP. Furnish material, **from Table 2**, conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1.b.1. Provide the Representative a copy of a signed Bill of Lading for the bituminous material on the first day of paving and when the batch number changes.

409AP.2(a)2 **Intermediate and Shoulde**r Mix Containing More than 15% RAP, **but less 30% RAP**. Furnish material, **from Table 2**, conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b)
and 702.1.b.1. Provide the Representative a copy of a signed Bill of Lading for the bituminous material on the first day of paving and when the batch number changes.

Table 2

Aircraft Gross Weight, (#)	**Asphalt Performance Grade (PG)**	
< 12,500	**PG 64-22**	
12,500 to < 60,000	**PG 76-22**	

409AP.2(d) Filler. Section 703.1(c)1. Do not use fly ash **for 75 gyration mixtures.**

409AP.2(e)1. Virgin Material Mixtures. Size, uniformly grade, and combine aggregate fractions in portions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mix Design requirements as specified in Bulletin, Chapter 2A, for the specified nominal maximum aggregate size. **The combined aggregate gradation shall be classified as coarse-graded when it passes below the Primary Control Sieve (PCS) control point as defined in Table 3. All other gradations shall be classified as fine-graded.**

Table 3 - Gradation Classification, After AASHTO M 323.

PCS Control Point for Mixture Nominal Maximum Aggregate Size (% Passing)					
Nominal Maximum Aggregate Size	37.5 mm	25.0mm	19.0 mm	12.5 mm	9.5 mm
Primary Control Sieve	9.5 mm	4.75 mm	4.75 mm	2.36 mm	2.36 mm
PCS Control Point (% Passing)	47	40	47	39	47

All surface course layers must be specified as the fine-graded aggregate classification.

Submit a copy of each completed JMF, signed by a certified HMA Level 2 plant technician, to the District Materials Engineer/District Materials Manager (DME/DMM) at least 3 weeks before the planned start of mix production. Include a list of all material sources and the HMA producer in the JMF. Provide the calibration factors (C_f and 200 C_f) required by PTM No. 757 with the JMF. Do not start mixture production until after the DME reviews the JMF.

Submit a new JMF with a change in material sources of if a new JMF is necessary to produce a mixture conforming to this specification.

409AP.2(e)1.c **Test Section [or Initial Production Lot]. Prior to full production, the contractor shall prepare and place a quantity of HMA mixture according to the job mix formula. As a minimum, and since joint density is required for acceptance, the amount of mixture shall be sufficient to construct a test section a minimum of 300 ft. long and 30 ft. wide, placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. A cold joint is an exposed construction joint at least 4 hours old or whose mat has cooled to less than 160^0 F. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in the construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. The lot will be divided in equal sublots.** The mixture ~~does not~~ must conform to the single and multiple sample tolerances in Tables A and B. Do not ship **additional** mixture to the project until after the Representative reviews and verifies the results conform to Tables A and B.

<u>TABLE A Composition Requirements of Completed Mixture, **Temperature of Mix**</u>

Temperature of Mixture (^{o}C (F))

Class of Material	Type of Material	Minimum	Maximum
PG 64-22	Asphalt Cement	130 (265)	160 (320)
PG 76-22	Asphalt Cement	140 (285)	165 (330)

409AP.2(e)2.a RAP. For HMA wearing courses, limit the RAP to a maximum of 15% of the mixture by mass (weight). **For HMA intermediate courses limit the RAP to a maximum of 30% of the mixture by mass (weight).**

409AP.2(f)1 <u>TABLE C Mixture Acceptance</u>

Acceptance Level	Acceptance Method
Lot Acceptance	Mixture Acceptance Sample Testing (Section 409.3(h)2

Delete 409AP.2(f)2, 2a, 2b, and 2c

409AP.3(b)1. Wearing Courses. Do not place courses specified with PG 76-22 from October 1 to March 31 in Districts 1-0, 2-0, 3-0, 4-0, 5-0 (Monroe and Carbon Counties), 9-0 (Cambria and Somerset Counties), and 10-0; and from October 16 to March 31 in District 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and

Somerset Counties), 11-0 and 12-0. No exceptions to paving weather limitations will be allowed, unless directed in writing by the District Executive.

409AP.3(h)2.a TABLE E Density Limits for Partially Completed Lots

Mixture Nominal Maximum Aggregate Size	**Density Limits**
9.5mm, 12.5mm and 19mm - Pavement	**$\geq$ 92 and < 97**
9.5mm, 12.5mm and 19mm - Longitudinal Joints	**$\geq$ 91 and < 97**

409AP.3(h)2.c Mixture Acceptance Sample Testing. **The contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. It shall be available for joint use by the Contractor for quality control and by the Engineer for acceptance testing and must have adequate equipment for the performance of tests required by these specifications. The Engineer shall have priority in use of the equipment necessary for acceptance testing.**

Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the contractor except that coring as required in this section shall be completed and paid by the contractor.

409AP.3(h)2.c.1. The mixture acceptance samples **will be tested** according to PTM No. 757 and PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 micron (#200) sieve. Calibration factors (C_f and 200 C_f) **will be** provided with the JMF for PTM No. 757. Test results **will be analyzed** for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 409.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 409.4(a)4 or Section 409.4(b).

If the asphalt content or the percent passing the 75 micron (#200) sieve is not within the single sample (n = 1) or multiple sample (n = 3) tolerances in Table A for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative receives the proposed solution and authorizes production to continue.

409AP.3(j)1. General. The Department will accept the mat **and longitudinal joint** density of standard construction according to one of the levels of Table F. Areas may be accepted by non-movement or optimum rolling pattern based on the criteria in Section 409AP.3(j)2 and 409.3(j)3. Do not place mixtures for non-movement or optimum-rolling pattern acceptance until the Department has approved the density acceptance level. For courses with mixture acceptance by certification, the density acceptance level will be either non-movement or optimum-rolling pattern.

The Department will accept the mat and **longitudinal joint** density by lots and pavement cores as specified in Section 409.3(j)4.
409AP.3(j)4.

409AP.3(j)4.a General. Pavement cores are required for accepting the density. Pavement cores are appropriate for accepting the density of standard construction if all of the following materials, conditions and applications exist:

409AP.3(k)1.a General. Offset joints in a layer from the joint in the layer immediately below by approximately 150 mm (6 inches).

409AP.3(k)1.d Longitudinal Joint Density Samples. Samples will be taken in accordance with Section 409.3(j)4.c, except only Column X of PTM 1 will be used in selecting the sample location for each sublot.

409AP.3(n) Protection of Courses. Do not allow traffic or loads on newly compacted courses until the course uniformly cools to a temperature of 60^o C (140^o F) or less.

409AP.3(p) Skid Resistance Surfaces / Saw-Cut Grooves. If shown on the plans, skid resistant surfaces for HMA pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving. Transverse grooves shall be saw-cut in the pavement forming a ¼-inch wide by ¼-inch deep by 1.5-inches center to center configuration. The grooves shall be continuous for the entire length of the groove. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for saw-cut grooves shall meet the following tolerances:

- **Alignment tolerance – Plus or minus 1.5-inches in alignment for 75 feet.**
- **Groove tolerance – Minimum depth 3/16-inch, except that not more than 60 percent of the grooves shall be less than ¼-inch. Maximum depth 5/16-inch. Minimum width ¼-inch. Maximum width 5/16-inch.**
- **Center-to-center spacing – Minimum 1-3/8-inches. Maximum spacing 1-5/8-inches.**

Grooves shall not be less than 6.0-inches and not more than 18.0-inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with the governing laws and regulations. All arrangements for disposal of waste materials shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

409AP.4(a)1.d Superpave Asphalt Mixture Design, HMA **Intermediate** Course. Square Meter (Square Yard) or Tonne (Ton)

409AP.4(a)1.e Superpave Asphalt Mixture Design, HMA **Intermediate** Course (Leveling). Tonne (Ton)

409AP.4(a) Table I, Delete Mat Density and substitute the following:

Mat and Longitudinal Joint Density

All Sizes	**Non-Movement**	**Section 409.3(j)2.**	**100**
	Optimum-Rolling Pattern	**Section 409.3(j)3.**	**100**
9.5 mm, 12.5 mm and 19 mm	**Acceptance Sample Testing of Mat Pavement Cores**	**All individual sublot test results for the lot are ≥ 92% and ≤ 97% of maximum theoretical density**	**100**
		Percent within tolerance if any individual sublot test result for the lot is not ≥ 92% and ≤ 97% of maximum theoretical density	**Table K**
9.5 mm, 12.5 mm and 19 mm	**Acceptance Sample Testing of Longitudinal Joint Cores**	**All individual sublot test results for the lot are ≥ 91% and ≤ 97% of maximum theoretical density**	**100**
		Percent within tolerance if any individual sublot test result for the lot is not ≥ 91% and ≤ 97% of maximum theoretical density	**Table K**

Table J
Upper and Lower Specification Limits for Calculating Percent Within Tolerance

	Testing Criteria	Testing Criteria

Mixture Nominal Maximum Aggregate Size	Lower Specification Limit (L)	Upper Specification Limit (U)
	Asphalt Content from	JMF Value, %
9.5mm, 12.5mm and 19mm	-0.4	+0.4
	Percent Passing the 75 micron JMF value,	(#200) sieve from %
9.5mm, 12.5mm and 19mm	-2.0	+2.0
	Mat	Density*
9.5mm, 12.5mm and 19mm	0.91T	0.98T
	Longitudinal Joint	Density
9.5mm, 12.5mm and 19mm	0.90T	0.98T
* Where T = Current	Maximum Theoretical Density,	kg/m3 (lbs./cf. ft.)

409AP.4(a)4.a Payment. The Representative will compute the percentage of the contract unit price paid as follows:

Lot Payment = C_p ($2P_D + P_B + P_A$) / 400

C_p = Contract unit price per lot (unit price times lot quantity)

P_D = Payment Factor Percentage for Density **(Pavement Factor x 0.75 + Longitudinal Joint Factor x 0.25)**

P_B = Payment Factor Percentage for Asphalt

P_A = Payment Factor Percentage for 75 micron (No. #200) sieve

Delete Section 409.4(a)4.b Retesting

409AP.4(b)1. Mixture Acceptance by Lot and Density Acceptance by Cores. Section 409.4(a), the Department will determine mat density by pavement **and longitudinal joint** cores only.

APPENDIX C2

PA DOT Section 409

Superpave Asphalt Concrete

SECTION 409—SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED HMA COURSES

409.1 DESCRIPTION—This work is the standard and RPS construction of plant-mixed HMA on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor.

409.2 MATERIALS—

(a) Bituminous Material

1. Virgin Mix or Mix Containing 5% to 15% RAP. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for bituminous material on the first day of paving and when the batch number changes.

2. Mix Containing More than 15% RAP. The MTD will evaluate the asphalt cement in the RAP source material. The MTD will determine the class (grade) of asphalt cement that the Contractor is required to use in the mixture.

Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for bituminous material on the first day of paving and when the batch number changes.

(b) Aggregate and RAM.

1. General Requirements. Provide aggregate from sources listed in Bulletin 14. Aggregate and RAM shall conform to the quality requirements for Superpave Asphalt Mixture Design as specified in Bulletin 27. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method.

2. Fine Aggregate. Section 703.1, except Table A gradation does not apply and as follows:

Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and conform to AASHTO M 323, Table 4. Determine the sand-equivalent value according to AASHTO T 176 and conform to AASHTO M 323, Table 4.

3. Coarse Aggregate. Type A, Section 703.2, except Table C gradation does not apply and revise the following quality requirements of Table B:

- Abrasion, Maximum Percent as specified in Bulletin 27, Chapter 2A, Table 5A
- Thin and Elongated Pieces, Maximum Percent as specified in AASHTO M 323, Table 5, for Flat and Elongated
- Crushed Fragments, Minimum Percent, as specified in AASHTO M 323, Table 5, for Fractured Faces, Coarse Aggregate

(c) RAP. If RAP material is proposed for use in the mixture, use at least 5% RAP consisting of cold milled or crushed hot-mix bituminous mixture. Include a plan to control RAP and the procedures to handle RAP of significantly different composition in the producer QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAP so that the final mixture conforms to Section 409.2(e).

(d) Filler. Section 703.1(c)1. Do not use flyash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs).

(e) Mixture Composition for Standard and RPS Construction.

1. Virgin Material Mixtures. Size, uniformly grade, and combine aggregate fractions in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements as specified in Bulletin 27, Chapter 2A, for the specified nominal maximum aggregate size and design ESALs.

Submit a copy of each completed JMF, signed by a certified HMA Level 2 plant technician, to the District Materials Engineer/District Materials Manager (DME/DMM) at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the HMA producer in the JMF. Provide the calibration factors (C_f and 200 C_f) required by PTM No. 757 with the JMF. Do not start mixture production until after the DME reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

1.a Producer QC Plan. Each producer must prepare a QC Plan as specified in Section 106 and conforming to the additional QC requirements of this specification. Submit the QC Plan to the DME annually at least 3 weeks before the planned start of mixture production and do not start production until the DME reviews the QC Plan.

1.a.1 QC Organization Chart.

- Names of personnel responsible for QC.
- Area of responsibility of each individual.
- List outside agencies, e.g., testing laboratories and a description of services provided.

1.a.2 Testing Plan with Action Points.

- List of all tests to be performed.
- Frequency of testing.
- List action points to initiate corrective procedures.
- Recording method to document corrective procedures.
- Procedures for conducting JMF verification testing.

1.a.3 Materials Storage and Handling.

- Aggregate/RAP/RAM stockpiles.
- Cold-feed systems for aggregates/RAP/RAM.
- Additives or modifiers for mixture
- Modified asphalt/liquid additive storage tanks.

- Surge/storage silos for mixture. Do not store more than one JMF in a surge/storage silo at any given time.

- All measuring and conveying devices, including calibration procedures.

- Haul vehicle loading procedures.

1.b Plant Technicians. During mixture production, provide a certified HMA Level 1 plant technician at the plant and an on-call certified HMA Level 2 plant technician, both meeting the requirements outlined in Publication 351. Instruct and train the certified technicians to perform all tests and to control plant operation. The Department may use its own certified HMA plant technicians to verify tests and to work in close cooperation with the producer's technicians. All technicians must carry a valid certification card during mixture production.

1.c Annual JMF Verification. During initial production of each JMF, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the single and multiple sample tolerances in Tables A and B within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the single and multiple sample tolerances in Tables A and B. During JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

1.d Production. After JMF verification, sample and test the mixture according to the QC Plan. For daily production of each JMF greater than 45 tonnes (50 tons), determine asphalt content, gradation, and theoretical maximum specific gravity from the same sample at least once each day. For daily production of each JMF greater than 140 tonnes (150 tons), determine asphalt content, gradation, theoretical maximum specific gravity and perform volumetric analysis of compacted specimens from the same sample at least once each day. Perform additional sampling and testing as directed. Produce a mixture within the following production limits:

1.d.1 Apparent Moisture Content. If the water absorption of a coarse aggregate, as determined by AASHTO T 85, exceeds 2.0%, sample the mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Determine the apparent moisture content in the mixture according to PTM No. 749. Produce a mixture with the apparent moisture content not to exceed 0.5%.

1.d.2 Asphalt Content. Include in the producer QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify that the mixture conforms to the tolerances of Table A. Test the samples according to either PTM No. 757, PTM No. 702, or PTM No. 742. After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table A. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table A using the running average of the last five consecutive test results.

Printed ticket results may be used in place of laboratory test results for QC of asphalt content of the mixture if the producer is currently approved to use printed tickets according to Bulletin 27. During mixture production, maintain 90% of printed ticket results for each day of production within 0.2 percentage points of the JMF. If RAP is used in the mixture, determine asphalt content by testing samples of the completed mixture.

1.d.3 Gradation. Sample the completed mixture, or sample the combined aggregate from the hot bins of a batch plant or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer QC Plan. If mineral filler or RAP are used in the mixture, determine gradation by testing samples of the completed mixture.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table A. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for the mixture, determine compliance with the multiple-sample tolerances using the running average of the last five consecutive test results.

1.d.4 Theoretical Maximum Specific Gravity. Sample the mixture according to PTM No. 1 at the frequency required in Bulletin 27. Condition and test the samples according to Bulletin 27.

Calculate the percentage of unfilled voids and the theoretical maximum density of the mixture using the most recently determined theoretical maximum specific gravity value or average value as specified in Bulletin 27. Certify the theoretical maximum specific gravity value to the Inspector daily using Form CS-4171 or another acceptable form. If the theoretical maximum specific gravity value varies 0.030 or more from the previous test or from the JMF value, immediately notify the DME.

1.d.5 Volumetric Analysis of Compacted Specimens. Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances of Table B. Determine the bulk specific gravity of the specimens as specified in AASHTO T 312 and calculate air voids (V_a) and Voids in Mineral Aggregate (VMA) at N_{design} according to AASHTO R 35 and as specified in Bulletin 27. Determine compliance with the multiple specimen tolerances using the average of the results for all specimens prepared from the sample.

TABLE A
Job-Mix Formula
Composition Tolerance Requirements of the Completed Mix

		Single Sample (n = 1)	**Multiple Samples (n $\geq$ 3)**
Gradation			
Passing 12.5 mm (1/2 inch) and Larger Sieves		±8%	±6%
Passing 9.5 mm (3/8 inch) to 150 µm (No. 100) Sieves (Inclusive)		±6%	±4%
Passing 75 µm (No. 200) Sieve		±3.0%	±2.0%
Asphalt Content			
19.0 mm HMA mixtures and smaller		±0.7%	±0.4%
25.0 mm HMA mixtures and larger		±0.8%	±0.5%
Temperature of Mixture (°C (F))			
Class of Material	**Type of Material**	**Minimum**	**Maximum**
PG 58-28	Asphalt Cement	125 (260)	155 (310)
PG 64-22	Asphalt Cement	130 (265)	160 (320)
PG 76-22	Asphalt Cement	140 (285)	165 (330)
All other PG Binders	Asphalt Cement	As specified in Bulletin 25 (Specifications for Bituminous Materials)	

TABLE B
Job-Mix Formula
Volumetric Tolerance Requirements of the Laboratory Compacted Mix

Property	**Each Specimen**	**Multiple Specimens**
Air Voids at N_{design} (V_a)	(±2%)	(±1.5%)
Minimum VMA % for 9.5 mm mixes	15.0	-
Minimum VMA % for 12.5 mm mixes	14.0	-

Minimum VMA % for 19.0 mm mixes	13.0	-
Minimum VMA % for 25.0 mm mixes	12.0	-
Minimum VMA % for 37.5 mm mixes	11.0	-

1.e Corrective Actions. Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table A.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content, as determined according to Section 409.2(e)1.d, are not within the tolerances in Table A
- QC test results on each specimen or on multiple specimens are not within the tolerances in Table B.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables A or B.

After taking corrective actions, sample the completed mixture within 140 tonnes (150 tons) of production. After sampling, test the mixture and provide test results to the Representative within 450 tonnes (500 tons) of production. If less than three samples are tested for mixture composition, determine conformance with Table A by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table A and the single and multiple specimen tolerances in Table B, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

2. Mixtures with RAM or 5% or More RAP. Section 409.2(e)1 and as follows:

2.a RAM and RAP SRL. For HMA wearing courses, limit the total combination of RAM and RAP to a maximum of 15% of the mixture by mass (weight) unless documentation of the SRL designation of the coarse aggregate in the RAM and RAP materials is provided to the DME and the RAM and RAP meet the specified SRL or can be blended for SRL as specified in Section 409.2(b)1.

2.b RAP Asphalt Content and Gradation. Determine the average asphalt content and gradation of the RAP stockpile according to Bulletin 27. Determine the proportions of RAP, RAM, and virgin materials necessary to conform to the JMF requirements. Maintain and provide the Representative access to records of all sampling, testing, and calculations.

(f) Mixture Acceptance.

1. General. For standard construction, the Department will accept the mixture according to the appropriate level in Table C. For RPS construction, the Department will accept the mixtures by lot acceptance as specified in Section 409.3(h)2.

TABLE C
Mixture Acceptance

Acceptance Level	Acceptance Method
Certification Acceptance	Producer Certification of Mixture (Section 409.2(f)2)
Lot Acceptance	Mixture Acceptance Sample Testing (Section 409.3(h)2)

2. Certification Acceptance. Acceptance by certification is appropriate for the following mixtures, conditions, or applications:

- Scratch courses, leveling courses less than 50 mm (2 inch) depth and driveway adjustments.
- Mixtures used by Department maintenance forces.
- Mixtures purchased by local or municipal governments.
- Mixtures placed in quantities not exceeding 450 tonnes (500 tons) in a continuous placement operation unless otherwise directed by the Representative.
- Other mixtures, conditions, or applications as approved by the Representative.

2.a General. Obtain certification from the mixture producer. Use all QC tests during mixture production as acceptance tests. Certify mixtures using Form CS-4171 or another acceptable form. Include, or attach, the QC test results on the form. Provide the form to the Inspector-in-Charge within 1 working day after completing the QC tests. Certify mixtures as specified in Section 106.03(b)3 and the requirements below.

2.b Certification of Mixture. Certify each mixture daily if QC test results conform to the single sample and multiple sample JMF production tolerances of Table A. The acceptance values will be:

- Asphalt Content
- Percent Passing the 2.36 mm (No. 8) sieve
- Percent Passing the 75 µm (No. 200) sieve

If using printed ticket results in place of laboratory test results for asphalt content, certify that at least 90% of each day's printed ticket results for asphalt content are within 0.2 percentage points of the JMF.

If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC test results to the Inspector-in-Charge. If using printed ticket results for asphalt content, provide the percentage of daily printed ticket results within 0.2 percentage points of the JMF to the Inspector-in-Charge. Payment will be determined according to Table H based on the QC test results.

If a day's production is interrupted by corrective action, material produced after the corrective action may be certified if QC test results conform to production tolerances.

2.c Maintaining Approval to Certify Mixtures. The Department may suspend a plant's approval to certify mixtures if QC is not performed according to the producer QC Plan, mixtures are not produced according to Bulletin 27, a mixture cannot be certified on 2 consecutive production days, or as described below.

The Department may take IA samples of the completed mixture at the plant. In the presence of the Department, test the IA samples for asphalt content and gradation according to the test methods indicated in the producer QC Plan. Take immediate corrective actions if the mixture does not conform to Table A.

The Department may take QA samples of the completed mixture at the plant or from directly behind the paver. The Department will test QA samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, for conformance to Table A. If the results of the QA samples do not comply with Table A, review the producer QC Plan and the QC test results that followed the QA samples for conformance to Table A. If QC results do not conform to Table A, perform the corrective actions necessary to provide a mixture conforming to Table A.

After completing corrective actions or the sample review, the Department will perform an on-site evaluation of the producer's plant operation and QC and then take a sample of the completed mixture at the plant. In the presence of the Representative, test the sample. If the sample does not comply with Table A, the Department will suspend certification. Immediately suspend shipping mixtures accepted by certification to the project.

After testing verifies that the produced mixture conforms to Tables A and B and with the Representative present, conduct JMF verification according to the producer QC Plan. After successfully completing JMF verification, resume both certification and shipping mixtures accepted by certification to the project.

409.3 CONSTRUCTION—

(a) Paving Operation QC Plan. Prepare a paving operation QC Plan, as outlined on Form CS-409, for field control and evaluation of bituminous concrete paving operations. Submit the QC Plan to the Representative before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the bituminous concrete courses as specified in Section 409.3. Do not start paving until after the Representative reviews the QC Plan.

(b) Weather Limitations. Do not place bituminous paving mixtures from November 1 to March 31, unless allowed in writing by the District Executive. Do not place bituminous paving mixtures when surfaces are wet or when the air or surface temperature is 4 °C (40F) or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

1. Wearing Courses. Do not place wearing courses specified with design ESALs of 10 million or greater or wearing courses specified with PG 76-22 from October 1 to March 31 in Districts 1-0, 2-0, 3-0, 4-0, 5-0 (Monroe and Carbon Counties), 9-0 (Cambria and Somerset Counties), and 10-0; and from October 16 to March 31 in Districts 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0, and 12-0. No exceptions to paving weather limitations will be allowed, unless directed in writing by the District Executive.

(c) Bituminous Mixing Plant. Obtain bituminous mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 11.1 m^2 (120 square feet). For recycled mixtures, add the following requirements:

1. Batch Plant. Modify the batch plant to measure the mass (weight) of the RAP before adding it into the pug mill. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP from segregating and sticking. Dry the virgin aggregate and RAM and then heat the virgin aggregate and RAM to a temperature that, after adding RAP, produces a completed mixture within the temperatures specified in Table A for the class and type of material used. Ensure that virgin aggregate is free of unburned fuel oil when delivered to the pug mill.

2. Drum Mixer Plant. Modify the drum mixer plant to prevent RAP from directly contacting the burner flame and prevent RAP from overheating. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP from segregating and sticking. Produce a completed mixture within the temperatures specified in Table A for the class and type of material used.

(d) Hauling Equipment. Haul the mixtures in tightly sealed vehicles that do not contain petroleum oils, solvents, or other materials that adversely affect bituminous concrete. Provide covers of sufficient size and quality to protect the entire load under all conditions. Maintain the proper and uniform placement temperature specified in Section 409.3(h)1. Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 10 °C (50F) from October 1 to April 30.

. **(e) Bituminous Pavers.** Provide self-contained, power-propelled units with activated screeds or activated strike-off assemblies and with automatic screed controls, capable of producing a finished surface of specified evenness and texture. Provide heated units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory laying of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the screeds.

Use hydraulic or other extension types against abutting lanes or longitudinal joints only if the unit feeds and activates the extension by the same method as the main screed. At the outside edge of pavement widths that cannot be uniformly placed, the Contractor may use a non-activated extension when approved by the Inspector-in-Charge.

Do not use equipment that tears, shoves, or gouges the mixture or that causes tracks, indented areas, flushing, segregation, or other permanent blemishes. Do not use blade graders or drags.

(f) Rollers. Use steel-wheel, pneumatic-tire, or vibratory rollers as specified in Section 108.05(c)3. Operate rollers according to manufacturer's recommendations. Use vibratory rollers with separate controls for vibration and propulsion.

(g) Preparation of Existing Surface.

1. Conditioning of Existing Surface. Before delivering bituminous mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a broom.

Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative’s satisfaction.

Paint existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with bituminous mixtures with a uniform coating of bituminous material, Class E-6 (AASHTO SS-1 or CSS-1), E-8 (AASHTO SS-1h or CSS-1h), Class AET applied in two or more applications, or of the class and type designated for the bituminous course.

Before overlaying existing surfaces, apply a tack coat as specified in Section 460 unless otherwise indicated. Apply a tack coat to previously placed courses if the Representative determines a tack coat is necessary to ensure bonding between the two courses.

2. Scratch and Leveling Courses. Where indicated, place a separate scratch or leveling course ahead of resurfacing operations. Use a scratch course to fill wheel ruts and other local small depressions even with the surrounding pavement. Use a leveling course to provide a relatively uniform working platform for placing binder or wearing courses.

(h) Spreading and Finishing.

1. General Requirements.

1.a Placing. Unless otherwise allowed, deliver, place, and compact bituminous paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place mixtures at the laying temperatures specified in Table A for the type and class of material used.

1.b Spreading and Finishing. Spread and strike off the mixture for the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth. After spreading, do not add mixture to the pavement mat that is segregated, below the minimum temperature, contains either a deficiency or an excess of asphalt content, or is otherwise unsuitable to add to the pavement mat.

If the course is more than 150 mm (6 inches) in compacted depth, construct it in two or more layers of approximately equal depth, with no layer less than 80 mm (3 inches) or more than 150 mm (6 inches) in compacted depth. For binder or leveling courses that have isolated areas exceeding 150 mm (6-inch) compacted depth, use a scratch or leveling course to eliminate the isolated areas before full-depth paving.

Immediately after placing the bituminous mixture, work the exposed outer edges to eliminate sharp, ragged, and open edges, to eliminate an unfinished appearance, and to reduce edge breakdown. Immediately repair edge breakdowns.

In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

Adjacent to flush curbs, gutters, and other abutting structures, place the wearing course mixture uniformly higher so that after compaction the finished surface is slightly above the edge of the abutting structure. Remove harmful material, clean, and seal the surface of wearing courses adjacent to curbs to form a bituminous gutter. Seal the mixture surface with a hot bituminous material of the class and type listed in Table A. Evenly apply the bituminous material a minimum width of 300 mm (12 inches) from the curb. The Contractor may use Class AET, Class E-6 (AASHTO SS-1 or CSS-1), or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material if allowed by the Inspector-in-Charge. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint along the curb. If necessary, apply emulsified asphalt in two or more applications. After sealing, remove excess sealant material.

1.c Field Technician. Provide a certified HMA field technician, with the qualifications outlined in Publication 351, to control the placement of bituminous mixtures. Instruct and train the certified HMA field technician to control the paving operation so that the completed paving work complies with the specified requirements. A certified HMA field technician must be onsite and carry a valid certification card during placement of all HMA mixtures.

2. Mixture Lot Acceptance (Standard and RPS Construction). Lot acceptance is appropriate for standard construction placed in quantities that allow consistent operation of the plant and is appropriate for RPS construction.

2.a Lots and Sublots. Material will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot consists of five equal sublots (n=5). A completed sublot has a mixture acceptance box sample as specified in Section 409.3(h)2.b and either a core collected according to PTM No. 1 or other density acceptance as specified in Section 409.3(j).

A normal lot size is 2 250 tonnes (2,500 tons) with five 450 tonnes (500 tons) sublots (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in Table D. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reason to adjust the lot size. The original lot will be continued when work resumes after short stoppages of less than 5 days. If a lot is terminated due to a stoppage of 5 days or more, adjust the lot size and number of sublots as specified in Table D. If work stoppages exceed 5 days, a new lot will be established.

TABLE D
Re-adjustment of Lot Size and Associated Number of Sublots

Remaining Quantity* Following Last Full Lot	Action
Less than 450 tonnes (500 tons) without a combination of one mixture acceptance sample and one core**	Quantity combined with the previous lot, (n=5)
Less than 450 tonnes (500 tons) with a combination of one mixture acceptance sample and one core**	One new sublot defined and quantity combined with the previous lot, (n=6)
450 tonnes (500 tons) to less than 900 tonnes (1,000 tons) without a combination of two mixture acceptance samples and two cores**	One new sublot defined and quantity combined with the previous lot, (n=6)
450 tonnes (500 tons) to less than 900 tonnes (1,000 tons) with a combination of two mixture acceptance samples and two cores**	Two new sublots defined and quantity combined with the previous lot, (n=7)
900 tonnes (1,000 tons) to less than 1 350 tonnes (1,500 tons) without a combination of three mixture acceptance samples and three cores**	Two new sublots defined and quantity combined with the previous lot, (n=7)
900 tonnes (1,000 tons) to less than 1 350 tonnes (1,500 tons) with a combination of three mixture acceptance samples and three cores**	New lot defined, (n=3)
1 350 tonnes (1,500 tons) to less than 1 800 tonnes (2,000 tons) without a combination of four mixture acceptance samples and four cores**	New lot defined, (n=3)
1 350 tonnes (1,500 tons) to less than 1 800 tonnes (2,000 tons) with a combination of four mixture acceptance samples and four cores**	New lot defined, (n=4)
1 800 tonnes (2,000 tons) to less than 2 250 tonnes (2,500 tons) without a combination of five mixture acceptance samples and five cores**	New lot defined, (n=4)
1 800 tonnes (2,000 tons) to less than 2 250 tonnes (2,500 tons) with a combination of five mixture acceptance samples and five cores**	New lot defined, (n=5)
*For contract items bid on an area basis, compute equivalent tons based on design depth of paving course and design density as specified in Section 110.04(b)4.a. ** If mat density is accepted using pavement cores.	

2.a.1 Partially Completed Lots (n=2 or less). When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 µm (No. 200) sieve, mixture acceptance samples will be evaluated individually using Section 409.2(e), Table A (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table E.

If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve meet the n=1 criteria of Table A, and samples tested for density meet the criteria in Table E, payment will be 100 percent of the contract unit price. If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve do not meet the n=1 criteria of Table A, the material will be considered defective work. If samples tested for density are no more than 2 percent below the minimum or no more than 2 percent above the maximum limits of Table E, payment will be 90 percent of the contract unit price. If samples for density are more than 2 percent below the minimum or more than 2 percent above the maximum limits of Table E, the pavement will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

TABLE E
Density Limits for Partially Completed Lots

MIXTURE NOMINAL MAXIMUM AGGREGATE SIZE	DENSITY LIMITS
All RPS 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses	≥ 92 and < 97
All Standard 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses	≥ 90 and < 97
All 25 mm and 37.5 mm Base Courses	≥ 88 and < 97

2.a.2 For JMF's placed in quantities less than 2 250 tonnes (2,500 tons). For JMF's placed in quantities of greater than 450 tonnes (500 tons) and less than 2 250 tonnes (2,500 tons) the tonnage will be considered a lot. The lot will be divided into five equal sublots.

For JMF's placed in quantities of 450 tonnes (500 tons) or less in a critical application, the tonnage will be considered a lot. The lot will be divided into three equal sublots.

2.b Mixture Acceptance Samples. The Inspector will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. In the presence of the Inspector, take one loose sample for each sublot from directly behind the paver.

Identify the samples by lot and sublot number, location, date of placement, mixture type, and as acceptance samples (Sample Class AS). Immediately package individual samples in cardboard boxes dimensioned approximately 95 mm x 120 mm x 240 mm (3 3/4 inches by 4 3/4 inches by 9 1/2 inches). Place the individually packaged samples for one lot in one container or tie the individually packaged samples for one lot together and submit the samples to the Inspector.

2.c Mixture Acceptance Sample Testing. Utilize MTD Testing unless otherwise indicated in the proposal. These procedures apply to standard and RPS construction.

2.c.1 MTD Testing. The MTD will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 µm (No. 200) sieve. The MTD will use the calibration factors (C_f and 200 C_f) provided with the JMF for PTM No. 757. The MTD will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 409.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 409.4(a)4 or Section 409.4(b).

If the asphalt content or the percent passing the 75 µm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table A for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative reviews the proposed solution and authorizes production to continue.

3. Pattern Segregation. Pattern segregation is continuous or repeated areas of non-uniform distribution of coarse and fine aggregate particles in the finished mat. The Department will address pattern segregation as follows:

3.a Evaluating Pattern Segregation. If the Representative observes pattern segregation that may result in defective pavement, then:

- The Inspector will notify the Contractor of the observed pattern segregation.
- The Contractor may continue to work at his or her own risk while he or she immediately and continually adjusts the operation to eliminate the pattern segregation from future work.
- As a minimum and in the presence of the Representative, determine the average depth of pavement surface macrotexture according to PTM No. 751 in areas with the pattern

segregation and in areas with non-segregated pavement. The pattern segregation is unacceptable if the difference in average pavement texture depth between the non-segregated and segregated areas exceeds 0.610 mm (0.024 inch). The Representative will determine if the pavement is defective as specified in Section 409.3(h)3.c.

3.b Test Section. If the macrotexture tests identify unacceptable pattern segregation, then:

- Immediately suspend placing the bituminous course. Evaluate the cause of pattern segregation according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the bituminous course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.

- Determine if the pattern segregation resulted in defective pavement as specified in Section 409.3(h)3.c.

- After the Representative allows paving to resume, place a test section not to exceed 180 tonnes (200 tons). If the corrective actions do not eliminate observed pattern segregation, the Department will suspend paving, even if it is before the Contractor places the entire test section. Propose additional corrective actions, and construct another test section. Resume normal paving operations after constructing an entire test section without pattern segregation as determined by the Representative.

3.c Defective Pavement. At locations selected by the Inspector and with the Inspector present, drill a minimum of three 152 mm (6-inch) diameter cores from the area of pattern segregation and a minimum of three cores from the pavement representing a non-segregated area. Do not compress, bend, or distort samples during cutting and handling and immediately provide the cores to the Inspector. The Inspector will transport cores to the producer's laboratory. With the Inspector present, test the cores at the plant for density, asphalt content, and gradation. The Department may request additional tests as part of its evaluation of pattern segregation. Determine the maximum theoretical density according to Bulletin 27, the core density according to PTM No. 715, and asphalt content according to PTM No. 757 if previously identified problematic aggregates are used in the mixture, PTM No. 702 modified Method D, or other test method identified in the producer QC Plan.

An area of pattern segregation contains defective pavement if the summation of absolute deviations from any two sieves is 20% or more from the JMF, the core density is defective, the mixture is defective in asphalt content, or the mixture is defective for percent passing the 75 µm (No. 200) sieve. Remove and replace the full width of the affected lane and a minimum of 1.5 m (5 feet) beyond each end of the area with unacceptable pattern segregation. Construct replacement pavement conforming to the appropriate surface tolerances as specified in Section 309.3(l)12 or Section 409.3(l).

(i) Compaction. Compact the mixture to achieve the density acceptance requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, amplitude, frequency, pattern, and roller size to eliminate displacement, shoving, cracking, and aggregate breakage. Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels. Use suitable methods to clean wheels of pneumatic-tire rollers.

Use pneumatic-tire rollers for compacting scratch courses.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of bituminous material. Replace removed mixture with fresh hot mixture and compact the mixture even with the surrounding pavement surface.

(j) Mat Density Acceptance.

1. General. The Department will accept the mat density of standard construction according to one of the levels in Table F. Areas may be accepted by non-movement or optimum-rolling pattern based on the criteria in

Sections 409.3(j)2 and 409.3(j)3. Do not place mixtures for non-movement or optimum-rolling pattern acceptance until the Department has approved the density-acceptance level. For courses with mixture acceptance by certification, the density acceptance level will be either non-movement or optimum-rolling pattern.

The Department will accept the mat density of RPS construction by lots and pavement cores as specified in Section 409.3(j)4.

TABLE F
Density Acceptance

Density Acceptance Level	Acceptance Criteria
Non-Movement	Table H
Optimum-Rolling Pattern	Table H
Pavement Cores*	Table I
* Use only when mixture acceptance is by lots.	

2. Non-Movement. The Inspector-in-Charge will approve density acceptance by non-movement for the following materials, conditions, or applications:

- Scratch courses or leveling courses less than 30 mm (1-inch) in depth or equal to or less than 60 kg/m^2 (110 pounds per square yard).
- Areas of paving or patching less than 1.2 m (4 feet) in width or narrow enough to cause bridging of the area by approved compaction equipment.

The Inspector-in-Charge will accept density by non-movement for the following materials, conditions, or applications if they are determined by the Representative to be non-critical for density:

- Materials placed in small quantities not exceeding 450 tonnes (500 tons) in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.
- Mixtures used for patching, road widening, shoulders, driveway adjustments, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 409.3(j)4.a.

The Department will accept the density when the mixture does not move under the compaction equipment.

3. Optimum-Rolling Pattern. The Inspector-in-Charge may accept density using an optimum-rolling pattern for the following materials, conditions, or applications:

- Materials placed in small quantities not exceeding 450 tonnes (500 tons) in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.
- Leveling courses or other courses that are greater than or equal to 30 mm (1-inch) in depth or greater than or equal to 60 kg/m^2 (110 pounds per square yard).
- Mixtures used for patching, road widening, driveway adjustments, shoulders where density is not critical, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 409.3(j)4.a

- Mixtures placed at less than the minimum compacted depths in Table G.

With the Inspector and the Contractor's certified HMA field technician present, determine density with an approved nuclear gauge according to PTM 402, or determine density with an approved electrical impedance gauge according to PTM No. 403. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Inspector, follow the control strip technique specified in PTM No. 402 to construct at least one control strip to establish the optimum-rolling pattern for each course. Document readings using the forms provided in PTM No. 402 and provide the completed forms to the Inspector. Compact the course according to the optimum-rolling pattern. During paving, the Representative may require the Contractor to construct a new control strip to verify the optimum-rolling pattern.

Use one of the following gauges or approved equal:

- Troxler Electronics, Model 3411B or Model 4640B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2
- TransTech Systems, Inc., PQI™, Model 300 or Model 301
- Troxler Electronic Laboratories, PaveTracker™

Submit a copy of the certificate of nuclear gauge annual calibration according to ASTM D 2950 and documentation of training of the nuclear gauge operator. Recalibrate any nuclear gauge that is damaged or repaired.

4. Pavement Cores (Standard and RPS Construction).

4.a General. Pavement cores are required for accepting the density of RPS construction. Pavement cores are appropriate for accepting the density of standard construction if all of the following materials, conditions, or applications exist:

- Mixture acceptance is by lots.

- Materials placed at compacted depths greater than or equal to the minimum depths specified in Table G.

- Materials placed on stable and uniform bases.

TABLE G
Mixture Minimum Compacted Depths

Mixture	Minimum Depth
9.5 mm Wearing Course	40 mm (1 1/2 in.)
12.5 mm Wearing Course	40 mm (1 1/2 in.)
19 mm Wearing and Binder Courses	50 mm (2 in.)
25 mm Binder Course	80 mm (3 in.)

4.b Lots and Sublots. Section 409.3(h)2.a.

4.c Density Acceptance Samples. The Inspector will select different sample locations in each sublot according to PTM No. 1, PTM No. 729, and PTM No. 746. With the Inspector present, drill 152 mm (6-inch) diameter cores as soon as possible but no later than the day following placement. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 300 mm (12 inches) of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

Identify the samples by lot number, location, date of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value from Section

409.2(e)1.d.4 for the density calculation of the lot. If density samples from the lot are taken from more than 1 day's placement, the average of the daily theoretical maximum specific gravity values from the days the lot was placed will be used to calculate the density. Immediately package and deliver the samples to the Inspector according to the QC Plan. Use sample containers of sufficient strength to prevent samples from being damaged during transport. Submit samples for one lot in one container.

4.d Acceptance Sample Testing. These procedures apply to standard and RPS construction.

4.d.1 MTD Acceptance Testing. The MTD will test the density acceptance samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. The Department will determine acceptance, with respect to density, as specified in Section 409.4(a)4 or Section 409.4(b).

If cores are not taken within 1 day after placing the mixture, or if the density for two consecutive lots or for a total of three lots does not meet the density payment factor percentage of 100, stop paving operations for the project as directed. Review and evaluate the operation and determine the cause of the problem. Do not resume paving until after the Representative reviews the proposed solution and authorizes paving to continue.

(k) Joints.

1. Longitudinal Joints.

1.a General. Offset joints in a layer from the joint in the layer immediately below by approximately 150 mm (6 inches). Plan joint locations to ensure that the joint in the top layer is at the approximate pavement centerline for two-lane roadways and within 300 mm (12 inches) of the lane lines for roadways with more than two lanes.

Before placing abutting lanes, paint the entire area of the joint with a uniform coating of bituminous material, the PG-Binder used in the pavement course or PG 64-22 .Painting of the joint face is not required for scratch courses.

Place and compact the mixture at the joint according to the Paving Operation QC Plan. Ensure the surface across the joint is smooth and the surface along the joint is within the surface tolerances specified in Section 409.3(l).

If traffic or other cause distorts the lane edge, restore the lane edge to its original shape, using acceptable procedures.

1.b Vertical Joints.

- The Contractor may use vertical joints for base, binder, and wearing courses.
- If traffic or other cause distorts the lane edge, carefully saw a vertical lane edge before painting.
- Place the abutting lane on the same day, and if necessary, leave only short lane sections, normally less than 8 m (25 feet) in length, where the abutting lane is not placed the same day.

1.c Notched Wedge Joints.

- The Contractor may use notched wedge joints for wearing and binder courses with nominal maximum aggregate size mixtures of 19.0 mm or smaller.
- Remove and dispose of all loose and foreign material before opening the lane to traffic.
- Construct the joint according to Standard Drawing RC-28.
- If the joint is next to opposing traffic, place the abutting lane within 1 working day after placing the mixture. If the joint is next to traffic in the same direction, place the abutting lane within 2 working days after placing the mixture.

- If both lanes that make the joint are not placed on the same day, amend the Maintenance and Protection of Traffic Plan and install additional signing for uneven lane at no additional cost to the Department. Install "Uneven Lane" signs according to Publication 212, Publication 213, and MUTCD and 1 km (1/2-mile) before the notched wedge joint area and every 1 km (1/2-mile) within the uneven pavement area.

2. Transverse Joints. Construct joints perpendicular to the pavement centerline. The Contractor may saw transverse joints. If used, install bulkheads straight and perpendicular to the surface. If a bulkhead is not used and the roller moves over the rounded edge of new mixture, locate the joint a sufficient distance from the rounded edge to provide a true surface and cross section. Paint the joint face with a thin coating of bituminous material, the PG-Binder used in the pavement course or PG 64-22, before placing fresh mixture against the joint face. Painting of the joint face is not required for scratch courses. .

3. Other Joints. Where placing a wearing course abutting to existing pavement at locations such as paving notches, lane additions, or utility openings, seal the joint with hot bituminous material of the class and type designated for the wearing course. Evenly apply the sealant a minimum of 150 mm (6 inches) on both sides of the joint. The Contractor may use a Class AET, Class E-6 (AASHTO SS-1 or CSS-1) or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material. Before sealing, clean and remove harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint. If necessary, use two or more applications of emulsified asphalt. Remove excess bituminous material and immediately cover the sealed area with a light application of dry sand that is acceptable to the Representative.

(l) Surface Tolerance. Test the finished surface with a 3 m (10-foot) straightedge at areas the Representative determines may be deficient or irregular, and at transverse joints and paving notches. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than one-half the length of the straightedge until the entire area is tested. The pavement is defective if irregularities are more than 5 mm (3/16 inch).

(m) Tests for Depth: Binder and Wearing Courses. Construct the pavement to the depth indicated and within the specified tolerances.

For courses with density acceptance by lots, the Inspector will measure the depth of each sublot according to PTM No. 737 using the density acceptance samples.

For courses with a designed course depth and density acceptance by non-movement or optimum rolling pattern, the Inspector will calculate the mass per square meter (weight per square yard) for verification of yield. If yield results indicate insufficient course depth, drill one 152 mm (6 inch) diameter core for each 450 tonnes (500 tons) of material placed to determine the extent of the deficient depth. Core locations will be determined using PTM No. 1. For courses with density acceptance by lots, the inspector will measure the depth of each sublot according to PTM No. 737 using density acceptance samples.

Pavement deficient in depth by more than 6 mm (1/4 inch) is defective work. Pavement deficient in depth by more than 3 mm (1/8 inch) in three or more adjacent core locations is defective work. The extent of the defective work is the entirety of all sublots represented by the adjacent deficient core samples. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 6 mm (1/4 inch) of the design depth.

(n) Protection of Courses. Do not allow vehicular traffic or loads on newly compacted courses for 24 hours or until the course uniformly cools to a temperature of 60 ºC (140F) or less. Provide alternate routes as indicated or as directed. If both lanes that form a longitudinal joint are placed on the same day and public safety is not restricted, do not allow vehicular traffic or loads on the lanes until adequate stability and adhesion is obtained and the material has uniformly cooled to 60 ºC (140F) or less. Maintain the course, as specified in Sections 105.13, 107.15, and 901.

(o) Defective Work. As specified in Section 105.12 and as follows:

Department acceptance and QA testing shall not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace or repair defective work as directed. The BOCM will review Representative determinations of defective material or workmanship.

Remove and replace pavement defective for pattern segregation as specified in Section 409.3(h)3, surface tolerance as specified in Section 409.3(l) or Section 309.3(l) and depth as specified in Section 409.3(m), or Section 309.3(m). Remove and replace pavement defective for percent within tolerance or Payment Factor Percentages as specified in Tables H and I.

409.4 MEASUREMENT AND PAYMENT—

(a) Standard HMA Construction.

1. HMA Courses.

1.a Superpave Asphalt Mixture Design, HMA Wearing Course. Square Meter (Square Yard) or Tonne (Ton)

1.b Superpave Asphalt Mixture Design, HMA Wearing Course (Scratch). Tonne (Ton)

1.c Superpave Asphalt Mixture Design, HMA Wearing Course (Leveling). Tonne (Ton)

1.d Superpave Asphalt Mixture Design, HMA Binder Course. Square Meter (Square Yard) or Tonne (Ton)

1.e Superpave Asphalt Mixture Design, HMA Binder Course (Leveling). Tonne (Ton)

2. Bituminous Tack Coat. Section 460.4.

3. Mixture Acceptance by Certification and Density Acceptance by Non-Movement and Optimum-Rolling Pattern. The Representative will pay at the contract unit price, adjusted according to Table H. The total payment factor percentage is the sum of adjustments for each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%. The pavement will be considered defective if the payment factor for asphalt content, percent passing the 75 μm (No. 200) sieve, and percent passing the 2.36 mm (No. 8) sieve are all 85%.

TABLE H
Contract Unit Price Adjustments - Mixture Acceptance by Certification

Mixture Nominal Maximum Aggregate Size	Test Criteria	Test Value		Payment Factor Percentage
Asphalt Content				
All sizes	Printed Tickets	At least 90% of Daily Printed Tickets Within 0.2% of JMF		100
		Less than 90% of Daily Printed Tickets Within 0.2% of JMF		85
19.0 mm and smaller	QC Sample Testing**	Single Sample (n=1)	Multiple Samples (n≥2)	
		±0.7%	±0.5%	100
		±0.8% to 1.0%	±0.6%	85
		> ±1.0%	≥ ±0.7%	*
25.0 mm and larger	QC Sample Testing**	±0.8%	±0.6%	100
		±0.9% to ±1.2%	±0.7%	85
		> ±1.2%	≥ ±0.8%	*
Gradation				
		Single Sample (n=1)	Multiple Samples (n≥2)	
All sizes	QC Sample Testing for % Passing 75 µm (No. 200) Sieve**	±3.0%	±2.1%	100
		±3.1% to ±4.0%	±2.2% to ±2.7%	85
		> ±4.0%	≥ ±2.8%	*
All sizes	QC Sample Testing for % Passing 2.36 mm (No. 8) Sieve**	±6%	±4%	100
		±7% to ±8%	±5%	85
		> ±8%	≥ ±6%	*
Mat Density				
All sizes	Non-Movement	Section 409.3(j)2.		100
	Optimum-Rolling Pattern	Section 409.3(j)3.		100

* Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 50% of the contract unit price.

** For these test criterion, the daily Payment Factor Percentage will be determined by the single sample test result from the daily QC sample. If more than one QC sample test result is available for a day, the Payment Factor Percentage will be determined based on the average of the results using multiple sample tolerances. If corrective action is taken, Payment Factor Percentages will be independently determined for material placed before and after the corrective action.

4. Mixture Acceptance by Lot and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores. The Department will pay on a lot-by-lot basis at the contract unit price, adjusted for Payment Factor Percentages as specified in Table I. For the payment factor percentages based on percent within tolerance, the Department will determine the percent within tolerance according to Section 106.03(a)3, using the upper and lower specification limits in Table J.

TABLE I
Contract Unit Price Adjustments - Mixture Acceptance by Lots

Mixture Nominal Maximum Aggregate Size	Test Criteria	Test Value	Payment Factor Percentage
		Asphalt Content	
All sizes	Acceptance Sample Testing	All individual sublot acceptance sample test results for the lot are within the n=1 tolerances in Table A and the lot average is within the n≥3 tolerances in Table A*	100
		Percent Within Tolerance if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances in Table A or the lot average is not within the n≥3 tolerances in Table A	Table K
		Gradation	
All sizes	Acceptance Sample Testing for % Passing 75 µm (No. 200) Sieve	All individual sublot acceptance sample test results for the lot are within the n=1 tolerances in Table A and the lot average is within the n≥3 tolerances in Table A*	100
		Percent Within Tolerance, if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances in Table A or the lot average is not within the n≥3 tolerances in Table A	Table K
		Mat Density	
All sizes	Non-Movement	Section 409.3(j)2.	100
	Optimum-Rolling Pattern	Section 409.3(j)3.	100
All RPS 9.5 mm, 12.5 mm, 19 mm and 25 mm Wearing or Binder Courses	Acceptance Sample Testing of Pavement Cores	All individual sublot test results for the lot are ≥92% and <97% of maximum theoretical density	100
		Percent Within Tolerance if any individual sublot test result for the lot is not ≥ 92% and < 97% of maximum theoretical density	Table K
All Standard 9.5 mm, 12.5 mm, 19 mm and 25 mm Wearing or Binder Courses	Acceptance Sample Testing of Pavement Cores	All individual sublot test results are ≥90% and <97% and the lot average is ≥92% and <97% of the maximum theoretical density	100
		Percent Within Tolerance if any individual sublot test result is not ≥90% and <97% or if the lot average is not ≥92% and <97% of the maximum theoretical density	Table K
All 25 mm and 37.5 mm Base Courses	Acceptance Sample Testing of Pavement Cores	All individual sublot test results are ≥88% and <97% and the lot average is ≥90% and <97% of the maximum theoretical density	100
		Percent Within Tolerance if any individual sublot test result is not ≥88% and <97% or if the lot average is not ≥90% and <97% of the maximum theoretical density	Table K

* The Department may elect to randomly select and test only one sublot mixture acceptance sample from each lot to verify conformance to the specifications. If only one sublot mixture acceptance sample is tested, tighter tolerances than those in Table A will be used to verify conformance to the specifications for the entire lot. If the one sublot is within ±0.2% of the JMF for asphalt content and within ±1.0% of the JMF for percent passing the 75 µm (No. 200) sieve, the lot will be considered to conform with the specifications and the lot's payment factor percentage will be determined according to this table. If the one sublot fails to meet the tighter tolerances, all mixture acceptance samples from the lot will be tested to determine the payment factor percentage according to this table.

TABLE J
Upper and Lower Specification Limits for Calculating Percent Within Tolerance

	Testing Criteria	
Mixture Nominal Maximum Aggregate Size	**Lower Specification Limit (L)**	**Upper Specification Limit (U)**
	Asphalt Content from JMF Value, %	
9.5 mm, 12.5 mm, and 19 mm	-0.4	+0.4
25 mm and 37.5 mm	-0.5	+0.5
	Percent Passing the 75 µm (No. 200) sieve from JMF Value, %	
All sizes	-2.0	+2.0
	Mat Density*	
9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing and Binder Courses	0.91T	0.98T
25 mm and 37.5 mm Base Courses	0.88T	0.98T
* Where T = Current Maximum Theoretical Density, kg/m3 (lbs./cu. ft.)		

TABLE K
Payment Factor Based on Percent Within Tolerance

Percent Within Tolerance	Payment Factor Percentage
99	97
98	97
97	97
96	96
95	96
94	96
93	95
92	95
91	95
90	95
89	93
88	91
87	90
86	88
85	86
84	84
83	83
82	81
81	79
80	78
79	76
78	74
77	72
76	71
75	69
74	67
73	66
72	64
71	62
70	60
69	59
68	57
67	55
66	54
65	52
64	50
Less than 64	Defective Lot**

**Remove and replace the lot. If only one lot characteristic has a percent within tolerance less than 64, the District Executive, with the concurrence of the Chief Engineer, may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

4.a Payment. The Representative will compute the percent of the contract unit price paid as follows:

Lot Payment = $C_P(2P_D + P_B + P_A)/400$

C_P = Contract unit price per lot (unit price times lot quantity)

P_D = Payment Factor Percentage for density

P_B = Payment Factor Percentage for asphalt content.

P_A = Payment Factor Percentage for percent passing the 75 µm (No. 200) sieve

4.b Retesting. For mixture acceptance testing or density acceptance testing performed by the MTD, the Contractor may request in writing that the Department retest a lot if the initial test results indicated a defective lot (remove and replace). Provide written retest requests to the District Executive within 3 weeks of the date the MTD test results are released. Retests will not be allowed if a written retest request is not received within 3 weeks of the date the MTD test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The MTD will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content or percent passing 75 µm (No. 200) sieve, the Inspector will identify the locations where the original box samples were collected. The Inspector will select retest sample locations 610 mm (24 inches) from the original sample locations longitudinally in the direction of traffic. If the 610 mm (24 inch) offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 610 mm (24 inches) from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill 152 mm (6-inch) diameter cores for retesting purposes. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture. Provide traffic control, core, and backfill the core holes at no cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702) will be used for the retest, unless the (DME/DMM) grants written approval for a change in test method. The cores will be rinsed with water before testing. The results of the retest cores will be used to calculate payment for both asphalt content and percent passing the 75 µm (No. 200) sieve for the lot.

For retesting of density acceptance, the original cores will be utilized. The MTD will not retest cores coated with paraffin wax as a result of PTM No. 716.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows:

Test	Retest Cost if Results Indicate 100% Pay Factor(s)	Retest Cost if Results Do Not Indicate 100% Pay Factor(s)
PTM No. 702/739	$900	$3,500
PTM No. 715	$200	$750
PTM No. 757	$500	$2,000

(b) HMA RPS Construction. Square Meter (Square Yard) or Tonne (Ton)

1. Mixture Acceptance by Lot and Density Acceptance by Pavement Cores. Section 409.4(a)4, except for RPS, the Department will determine mat density by pavement cores only.

APPENDIX D1

State Test Case #4, Texas:

TxDOT Item 341A

Special Provisions, Airport Pavement, <60,000 AGW

Dense-Graded Hot-Mix Asphalt (QC/QA)

TxDOT Item 341A – Special Provisions, Airport Pavement, <60,000 AGW Dense-Graded Hot-Mix Asphalt (QC/QA)

For this project, Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA)," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 341.2. Materials, Section A. Aggregate is voided and replaced by the following:

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

Article 341.2. Materials, Section A. Aggregate, Section 1. Coarse Aggregate. The second paragraph is voided and replaced by the following:

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.

Article 341.2. Materials, Section A. Aggregate, Section 2. RAP is voided and replaced by the following:

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

Use of Contractor-owned RAP including HMA plant waste is permitted, unless otherwise noted in the plans. Department-owned RAP stockpiles are available for the Contractor's use when the stockpile locations are shown on the plans. Department-owned RAP generated through required work on the Contract is available for the Contractor's use when shown on the plans. Perform any necessary tests to ensure Contractor or Department-owned RAP is appropriate for use. Unless otherwise shown on the plans, the Department will not perform any tests or assume any liability for the quality of the Department-owned RAP. When shown on the plans, the contractor will retain ownership of RAP generated on the project.

Fractionated RAP is defined as having two or more RAP stockpiles, whereas the RAP is divided into coarse and fine fractions. The coarse RAP stockpile will contain only material retained by processing over a 3/8 in. screen or 1/2 in. screen, unless otherwise approved. The fine RAP stockpile will contain only material passing the 3/8 in. screen or 1/2 in. screen, unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 3/8 in. screen or 1/2 in. screen to fractionate the RAP. The maximum percentages of fractionated RAP may be comprised of coarse or fine fractionated RAP or the combination of both coarse and fine fractionated RAP. Utilize a separate cold feed bin for each stockpile of fractionated RAP used.

Determine asphalt content and gradation of RAP stockpiles for mixture design purposes. Perform other tests on RAP when shown on the plans. “Surface” mixtures are defined as mixtures that will be the final lift or riding surface of the pavement structure. “Non-Surface” mixtures are defined as mixtures that will be an intermediate or base layer in the pavement structure. The allowable percentages shown in Table 1a may be changed when shown on the plans. Do not use a source of RAP contaminated with dirt or other objectionable materials, including coal tar sealant. Do not use a source of RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with Tex-406-A, Part I. Determine the plasticity index in accordance with Tex-106-E if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction.

Table 1a
Limitations on use of RAP

Mixture Application	**Unfractionated RAP, % max**	**Fractionated RAP, % max**
Trafficked	10	20
Non-trafficked Non-Surface, < 8 inches beneath	20	30
Non-Surface, ≥ 8 inches beneath	30	40

1. Runways, taxiways, ramps, and aprons
2. Shoulders, miscellaneous paved areas not subjected to aircraft traffic
3. More than half of the thickness of the lift in question is less than 8 inches beneath the surface
4. More than half of the thickness of the lift in question is at least 8 inches beneath the surface

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

Article 341.2 Materials, Section E. Tack Coat is deleted and replaced by FAA P-603, Bituminous Tack Coat.

Article 341.2. Materials, Section F. Additives is supplemented by the following:

Warm Mix Asphalt (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 by the plans, produce an asphalt mixture within the temperature range of 215ºF and 275ºF. When WMA is not required as shown on plans, produce an asphalt mixture within the temperature range of 215ºF and 350ºF. Unless otherwise directed, use only WMA additives or processes listed on the Department's approved list maintained by the Construction Division.

Article 341.4. Construction, Section D. Mixture Design. The first paragraph and Table 7 are voided and replaced by the following:

The Contractor may elect to design the mixture using a Texas Gyratory Compactor (TGC) or a Superpave Gyratory Compactor (SGC). Use the typical weight design example given in Tex-204-F, Part I when using a TGC or the Superpave mixture design procedure given in Tex-204-F, Part IV when using a SGC. Design the mixture to meet the requirements listed in Tables 1, 2, 3, 6, 7, and 8. When using the TGC, design the mixture at 97.0% target laboratory-molded density or as noted in Table 7. When using the SGC, design the mixture at 50 or 65 gyrations (N_{des}) as shown on the plans.

Use an approved laboratory to perform the Hamburg Wheel test and provide results with the mixture design or provide the laboratory mixture and request that the Department perform the Hamburg Wheel test. The TxDOT 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.

Table 7
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Target laboratory-molded density, %	Tex-207-F	97.
Design gyrations ( )	Tex-241-F	50 or 65
Tensile strength (dry), psi	Tex-226-F	85-
Boil	Tex-530-C	-

1. May be adjusted within a range of 96.0–97.5% when shown on the plans or allowed by the Engineer when using the TGC (Tex-204-F, Part I).
2. May be adjusted within a range of 50–100 gyrations when shown on the plans or allowed by the Engineer when using the SGC (Tex-204-F, Part IV).
3. May exceed 200 psi when approved and may be waived when approved.
4. Used to establish baseline for comparison to production results.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval. The first paragraph is voided and replaced by the following:

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 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.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (1) Providing Texas Gyratory Compactor is voided and replaced by the following:

(1) Providing Gyratory Compactor. Use a Texas Gyratory Compactor (TGC) calibrated in accordance with Tex-914-K when electing or required to design the mixture in accordance with Tex-204-F, Part I, for molding production samples. Furnish a Superpave gyratory compactor (SGC) calibrated in accordance with Tex-241-F when electing or required to design the mixture in accordance with Tex-204-F, Part IV, for molding production samples. If the SGC is used, locate the SGC at the Engineer's field laboratory and make the SGC available to the Engineer for use in molding production samples.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (2) Gyratory Compactor Correlation Factors is voided and replaced by the following:

(2) Gyratory Compactor Correlation Factors. Use Tex-206-F, Part II, to perform a gyratory compactor correlation when the Engineer uses a different gyratory compactor. Apply the correlation factor to all subsequent production test results.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (6) Ignition Oven Correction Factors is voided and replaced by the following:

(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, provided that the mixture design and ignition oven are the same as previously used, unless otherwise directed.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (8) Trial Batch Approval is voided and replaced by the following:

(8) Trial Batch Approval. Upon receiving conditional approval of JMF1 from the Engineer, provide a plant-produced trial batch including the WMA additive or process, if applicable for verification testing of JMF1 and development of JMF2.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Table 9 is voided and replaced by the following:

Table 9
Operational Tolerances

Description	Test Method	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.	±5.0
Individual % retained for sieves smaller than #8 and larger than #200		±3.	±3.0
% passing the #200 sieve		±2.	±1.6
Asphalt content, %	Tex-236-F	±0.	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0
In-place air voids, %		N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	±0.020
VMA, %, min		Note 4	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	±0.020

1. Contractor may request referee testing only when values exceed these tolerances.
2. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
3. Tolerance between trial batch test results and JMF1 is not allowed to exceed 0.5%, unless otherwise directed. Tolerance between JMF1 and JMF2 is allowed to exceed ± 0.3%.
4. Test and verify that Table 6 requirements are met.

Article 341.4. Construction, Section D. Mixture Design, Table 6

Table 6 is voided and replaced as follows:

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

Sieve Size	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
1-1/2"	98.0–100.0	–	–	–	–
1"	78.0–94.0	98.0–100.0	–	–	–
3/4"	64.0–85.0	84.0–98.0	95.0–100.0	–	–
1/2"	50.0–70.0	–	–	98.0–100.0	–
3/8"	–	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	30.0–50.0	40.0–60.0	43.0–63.0	50.0–70.0	80.0–86.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#30	8.0–23.0	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	3.0–19.0	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
Design , % Minimum					
–	12.5	13.5	14.5	15.5	16.5
Plant-Produced VMA, % Minimum					
–	11.5	12.5	13.5	14.5	15.5

1. Voids in mineral aggregates.

Article 341.4. Construction, Section D. Mixture Design, Section 2, Job-Mix Formula Approval, Section b. Engineer's Responsibilities, Section (1) Gyratory Compactor is voided and replaced by the following:

(1) Gyratory Compactor. For mixtures designed in accordance with Tex-204-F, Part I, the Engineer will use a Department TGC, calibrated in accordance with Tex-914-K, to mold samples for trial batch and production testing. The Engineer will make the Department TGC and the Department field laboratory available to the Contractor for molding verification samples, if requested by the Contractor.

For mixtures designed in accordance with Tex-204-F, Part IV, the Engineer will use a Department SGC, calibrated in accordance with Tex-241-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location. The Engineer will make the Contractor-provided SGC in the Department field laboratory available to the Contractor for molding verification samples.

Article 341.4. Construction, Section E. Production Operations, Section 2. Mixing and Discharge of Materials is supplemented with the following:

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 275ºF or is less than 215ºF. When WMA is specified, the Department will not pay for or allow placement of any WMA produced at more than 275ºF or less than 215ºF, unless otherwise directed.

Article 341.4. Construction, Section G. Placement Operations is voided and replaced by the following:

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. Measure and record the 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 directed, calculate the daily and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day. The Engineer may suspend production if the Contractor fails to produce haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 in. Place mixture so longitudinal joints on the surface course are aligned as directed by the Engineer. Ensure that all finished surfaces will drain properly. Place mixture within the compacted lift thickness shown in Table 10, unless otherwise shown on the plans or allowed.

Article 341.4. Construction, Section G. Placement Operations, Section 1. Weather Conditions is voided and replaced with the following:

1. Weather Conditions. Place mixture when the roadway surface temperature is equal to or higher than the temperatures listed in Table 10A, unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a handheld infrared thermometer. The Engineer may allow mixture placement to begin prior to the roadway surface reaching the required temperature requirements if conditions are such that the roadway surface will reach the required temperature within 2 hrs. of beginning placement operations. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

Article 341.4. Construction, Section G. Placement Operations, Section 1. Weather Conditions is supplemented by the following:

Table 10A
Minimum Pavement Surface Temperatures

	Minimum Pavement Surface Temperatures in Degrees Fahrenheit	
High Temperature Binder Grade	**Subsurface Layers or Night Paving Operations**	**Surface Layers Placed in Daylight Operations**
PG 64 or lower	45	50
PG 70	55[1]	60[1]
PG 76 or higher	60[1]	60[1]

1. Contractors may pave at temperatures 10°F lower than the values shown in Table 10A when utilizing a paving process including WMA 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.

Article 341.4. Construction, Section G. Placement Operations, Section 2. Tack Coat is voided and replaced by FAA P-603.

Article 341.4. Construction, Section G. Placement Operations, Section 3. Lay-Down Operations. The first paragraph is voided and not replaced.

Article 341.4. Construction, Section G. Placement Operations, Section 3. Lay-Down Operations. Table 11 is voided and not replaced.

Article 341.4. Construction, Section I. Acceptance Plan, Section 1. Referee Testing. The first sentence in the first paragraph is voided and replaced with the following:

The referee laboratory is designated by the Engineer.

Article 341.4. Construction, Section I. Acceptance Plan, Section 1. Referee Testing. The second paragraph is voided and replaced with the following:

The designated referee laboratory will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory, and the Engineer's average maximum theoretical specific gravity for the lot. With the exception of "remove and replace" conditions, referee test results are final and will establish pay adjustment factors for the sublot in question. The Contractor may decline referee testing and accept the Engineer's test results when the placement pay adjustment factor for any sublot results in a "remove and replace" condition. Sublots subject to be removed and replaced will be further evaluated in accordance with Article 341.6, "Payment."

Article 341.4. Construction, Section I. Acceptance Plan, Section 2. Production Acceptance, Section c. Production Testing. The first paragraph is voided and replaced with the following:

The Contractor and Engineer must perform production tests in accordance with Table 12. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. The Engineer may use asphalt content results from quality control testing performed by the Contractor to determine VMA. Determine compliance with operational tolerances listed in Table 9 for all sublots.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section a. Placement Lot, Section (1) Lot 1 Placement is voided and replaced by the following:

(1) Lot 1 Placement. Place a quantity of hot mix as a test section at least 300 ft. long and 30 ft wide at the same thickness as the course it represents. The test section will include a longitudinal cold joint, where the first lane has cooled to less than 160F before the second lane is placed. Place the test section over a similar pavement structure prepared in the same manner as the remainder of the course using the same equipment and procedures.

Placement bonuses for Lot 1 will be in accordance with Section 341.6.B, "Placement Pay Adjustment Factors." However, no placement penalty will be assessed for any sublot placed in Lot 1 when in-place air voids are greater than or equal to 2.7% and less than or equal to 8.9%. Remove and replace any sublot with in-place air voids less than 2.7% or greater than 8.9%.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section a. Placement Lot, Section (2) Incomplete Placement Lots is voided and replaced by the following:

(2) Incomplete Placement Lots. An incomplete placement lot consists of the area placed as described in Section 341.4.I.2.a(2), "Incomplete Production Lot," excluding miscellaneous areas as defined in Section 341.4.I.3.a(4), "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production sublot.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section b. Placement Sampling. The third and fifth paragraphs are voided and replaced by the following:

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

If the core heights exceed the minimum untrimmed values listed in Table 10, trim and deliver the cores to the Engineer within 1 working day following placement operations, unless otherwise approved. Trim the bottom or top of the core only when necessary to remove any foreign matter and to provide a level and smooth surface for testing. Foreign matter is another paving layer, such as hot mix, surface treatment, subgrade, or base material. Trim no more than 1/2 in. of material. Do not trim the core if the surface is level and there is not foreign matter bonded to the surface of the core.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section c. Placement Testing is voided and replaced by the following:

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

Delete paragraph 341.4.I.4 Ride Quality.

Add paragraph 341.4.J., as follows:

Skid Resistance Surfaces/Saw-Cut Grooves. If shown on the plans, skid resistant surfaces for HMA pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving. Transverse grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1-½ inches center to center configuration. The grooves shall be continuous for the entire length of the groove. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for saw-cut grooves shall meet the following:

- **Alignment tolerance –** Plus or minus 1-½ inches in alignment for 75 feet.
- **Groove tolerance –** Minimum depth 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch. Maximum depth 5/16 inch. Minimum width ¼ inches. Maximum width 5/16 inch.

- **Center-to-center spacing –** Minimum spacing 1-3/8 inches. Maximum spacing 1-5/8 inches.

Grooves shall not be less than 6.0 inches and not more than 18.0 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with governing laws and regulations. All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

Add paragraph 341.4.K., as follows:

Smoothness. The final surface shall be free from roller marks. The finished surfaces of each course of the pavement, except the finished surface of the final course, shall not vary more than ⅜ inch when evaluated with a 16 foot straightedge. The finished surface of the final course of pavement shall not vary more than ¼ inch when evaluated with a 16 foot straightedge. The lot size shall be 2,000 square yards. Smoothness measurements shall be made at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made at the center of each paving lane. In the transverse direction, smoothness readings shall be made continuously across the full width of the pavement. However, transverse smoothness readings shall not be made across designed grade changes. At warped transition areas, straightedge position shall be adjusted to measure surface smoothness and not design grade transitions. When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.

Add paragraph 341.4.L., as follows:

Grade. The finished surface of the pavement shall not vary from the grade line elevations and cross sections shown on the plans by more than ½ inch (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet) to determine the elevation of the completed pavement. The Contractor shall pay the cost of surveying of the level runs that shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer. The lot size shall be 2,000 square yards (square meters). When more than 15 percent of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates ¾ inch or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. The surface of the ground pavement shall have a texture consisting of grooves between 0.090 and 0.130 inches wide. The peaks and ridges shall be approximately 1/32 inch higher than the bottom of the grooves. The pavement shall be left in a clean condition. The removal of all of the slurry resulting form the grinding operation shall be continuous The grinding operation should be controlled so the residue from the operation does not flow across other lanes of pavement. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.

Article 341.6. Payment. The first paragraph is voided and replaced by the following:

The work performed and materials furnished in accordance with this Item and measured as provided under Article 341.5, "Measurement," will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the type, surface aggregate classification, and binder specified. When shown on the plans, "level up" may be specified. Pay adjustments for bonuses and penalties will be applied as determined in this Item except for level ups where a pay adjustment factor of 1.000 will be assigned for all production and placement sublots. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals.

Article 341.6. Payment, Section A. Production Pay Adjustment Factors is supplemented by the following:

When WMA is specified on the plans, at the Contractor's request the Engineer has the option to assign all sublots a production pay adjustment factor of 1.000. When the Engineer elects to assign all sublots a production pay adjustment factor of 1.000, control mixture production to yield a laboratory-molded density with an absolute deviation no greater than 1.0 percent from the target laboratory-molded density as defined in Table 7 or as shown on plans, as tested by the Engineer. The Engineer may suspend production and shipment of mixture if the laboratory-molded density deviates more than 1.0 percent from the target laboratory-molded density for two consecutive sublots.

Article 341.6. Payment, Table 14, Production Pay Adjustment Factors for Laboratory-Molded Density is replaced by the following:

Table 14
Production Pay Adjustment Factors
for Laboratory-Molded Density

Absolute Deviation from Target Laboratory-Molded Density	Production Pay Adjustment Factor
0.0	1.000
0.1	1.000
0.2	1.000
0.3	1.000
0.4	1.000
0.5	1.000
0.6	1.000
0.7	1.000
0.8	1.000
0.9	1.000
1.0	1.000
1.1	0.965
1.2	0.930

1.3	0.895
1.4	0.860
1.5	0.825
1.6	0.790
1.7	0.755
1.8	0.720
> 1.8	Remove and replace

Article 341.6. Payment, Section B. Placement Pay Adjustment Factors, Section 2. Placement Sublots Subject to Removal and Replacement is voided and replaced by the following:

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

Article 341.6. Payment, Section B. Placement Pay Adjustment Factors, Table 15 Placement Pay Adjustment Factors for In-Place Air Voids is voided and replaced by the following:

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

In-Place Air Voids	Placement Pay Adjustment Factor	In-Place Air Voids	Placement Pay Adjustment Factor
< 2.7	Remove and Replace	6.4	1.000
2.7	0.705	6.5	1.000
2.8	0.720	6.6	1.000
2.9	0.735	6.7	1.000
3.0	0.750	6.8	1.000
3.1	0.765	6.9	1.000
3.2	0.780	7.0	1.000
3.3	0.795	7.1	1.000
3.4	0.810	7.2	1.000
3.5	0.825	7.3	1.000
3.6	0.840	7.4	1.000
3.7	0.855	7.5	1.000
3.8	0.870	7.6	1.000
3.9	0.885	7.7	1.000
4.0	0.900	7.8	1.000
4.1	0.915	7.9	1.000
4.2	0.930	8.0	1.000
4.3	0.945	8.1	1.000
4.4	0.960	8.2	1.000
4.5	0.975	8.3	1.000
4.6	0.990	8.4	1.000
4.7	1.000	8.5	1.000
4.8	1.000	8.6	0.998
4.9	1.000	8.7	0.996
5.0	1.000	8.8	0.994
5.1	1.000	8.9	0.992
5.2	1.000	9.0	0.990
5.3	1.000	9.1	0.960
5.4	1.000	9.2	0.930
5.5	1.000	9.3	0.900
5.6	1.000	9.4	0.870
5.7	1.000	9.5	0.840
5.8	1.000	9.6	0.810
5.9	1.000	9.7	0.780
6.0	1.000	9.8	0.750
6.1	1.000	9.9	0.720
6.2	1.000	> 9.9	Remove and Replace
6.3	1.000		

APPENDIX D2

State Test Case #4, Texas:

TxDOT Item 341

Dense-Graded Hot-Mix Asphalt (QC/QA)

TxDOT Item 341

DENSE-GRADED HOT-MIX ASPHALT (QC/QA)

341.1. Description. Construct a pavement layer composed of a compacted, dense-graded mixture of aggregate and asphalt binder mixed hot in a mixing plant.

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

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

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

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

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

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

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

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

When RAP is allowed by plan note, use no more than 30% RAP in Type A or B mixtures unless otherwise shown on the plans. For all other mixtures, use no more than 20% RAP unless otherwise shown on the plans.

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

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

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

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

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	AQMP	As shown on plans
Deleterious material, %, max	Tex-217-F, Part I	1.5
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	40
Magnesium sulfate soundness, 5 cycles, %, max	Tex-411-A	30
Coarse aggregate angularity, 2 crushed faces, %, Min	Tex 460-A, Part I	
Flat and elongated particles @ 5:1, %, max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, Max	Tex-107-E	3
Combined		
Sand equivalent, %, Min	Tex-203-F	45

1. Not used for acceptance purposes. Used by the Engineer as an indicator of the need for further investigation.
2. Only applies to crushed gravel.
3. Aggregates, without mineral filler, RAP, or additives, combined as used in the job-mix formula (JMF).

Table 2
Gradation Requirements for Fine Aggregate

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

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

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

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

Table 3
Gradation Requirements for Mineral Filler

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

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

D. Asphalt Binder. Furnish the type and grade of performance-graded (PG) asphalt binder specified on the plans in accordance with Section 300.2.J, “Performance-Graded Binders.”

E. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

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

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

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

341.3. Equipment. Provide required or necessary equipment in accordance with Item 320, “Equipment for Asphalt Concrete Pavement.”

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

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

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

1. Aggregate Testing	**Test Method**	**Contractor**	**Engineer**	**Level**
Sampling	Tex-400-A	✓	✓	IA
Dry sieve	Tex-200-F, Part I	✓	✓	IA
Washed sieve	Tex-200-F, Part II	✓	✓	IA
Deleterious material	Tex-217-F, Part I	✓	✓	II
Decantation	Tex-217-F, Part II	✓	✓	II
Los Angeles abrasion	Tex-410-A		✓	
Magnesium sulfate soundness	Tex-411-A		✓	
Micro-Deval abrasion	Tex-461-A		✓	
Coarse aggregate angularity	Tex-460-A	✓	✓	II
Flat and elongated particles	Tex-280-F	✓	✓	II
Linear shrinkage	Tex-107-E	✓	✓	II
Sand equivalent	Tex-203-F	✓	✓	II
Organic impurities	Tex-408-A	✓	✓	II
2. Mix Design & Verification	**Test Method**	**Contractor**	**Engineer**	**Level**
Design and JMF changes	Tex-204-F	✓	✓	II
Mixing	Tex-205-F	✓	✓	II
Molding (TGC)	Tex-206-F	✓	✓	IA
Laboratory-molded density	Tex-207-F	✓	✓	IA
VMA (calculation only)	Tex-207-F	✓	✓	II
Rice gravity	Tex-227-F	✓	✓	IA
Ignition oven	Tex-236-F	✓	✓	II
Indirect tensile strength	Tex-226-F	✓	✓	II
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	Tex-236-F	✓	✓	IA
Control charts	Tex-233-F	✓	✓	IA
Moisture content	Tex-212-F	✓	✓	IA

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

3. Production Testing	**Test Method**	**Contractor**	**Engineer**	**Level**
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
In-Place air voids	Tex-207-F	✓	✓	IA
Establish rolling pattern	Tex-207-F	✓		IB
Control charts	Tex-233-F	✓	✓	IA
Ride quality measurement	Tex-1001-S	✓	✓	IB
Segregation (density profile)	Tex-207-F, Part V	✓	✓	IB
Longitudinal joint density	Tex-207-F, Part VII	✓	✓	IB
Thermal profile	Tex-244-F	✓	✓	IB
Tack coat adhesion	Tex-243-F		✓	IB

1. Refer to Section 341.4.I.2.c for exceptions to using an ignition oven.

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

Table 5
Reporting Schedule

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

1. These tests are required on every sublot.
2. Optional test. To be reported as soon as results become available.
3. To be performed at the frequency shown in Table 12.
4. Additional time is allowed if cores cannot be dried to constant weight within 1 day.

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

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

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

Sieve Size	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
1-1/2"	98.0–100.0	–	–	–	–
1"	78.0–94.0	98.0–100.0	–	–	–
3/4"	64.0–85.0	84.0–98.0	95.0–100.0	–	–
1/2"	50.0–70.0	–	–	98.0–100.0	–
3/8"	–	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	30.0–50.0	40.0–60.0	43.0–63.0	50.0–70.0	80.0–86.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#30	8.0–23.0	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	3.0–19.0	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
Design , % Minimum					
–	12.0	13.0	14.0	15.0	16.0
Plant-Produced VMA, % Minimum					
–	11.0	12.0	13.0	14.0	15.0

1. Voids in mineral aggregates.

Table 7
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Target laboratory-molded density, %	Tex-207-F	96.
Tensile strength (dry), psi (molded to 93% ±1% density)	Tex-226-F	85–
Boil	Tex-530-C	–

1. Unless otherwise shown on the plans.
2. May exceed 200 psi when approved and may be waived when approved.
3. Used to establish baseline for comparison to production results. May be waived when approved.

Table 8
Hamburg Wheel Test

High-Temperature Binder Grade	Minimum # of @ 0.5" Rut Depth, Tested @ 122°F
PG 64 or lower	10,000
PG 70	15,000
PG 76 or higher	20,000

1. Tested in accordance with Tex-242-F.
2. May be decreased or waived when shown on the plans.

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

   a. **Responsibilities.**

      (1) **Providing Texas Gyratory Compactor.** If molding production samples, use a Texas Gyratory Compactor (TGC) calibrated in accordance with Tex-914-F. When allowed, the Contractor may use the Department’s TGC.

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

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

(6) Ignition Oven Correction Factors. Determine the aggregate and asphalt correction factors from the ignition oven using Tex-236-F. Provide the Engineer with split samples of the mixtures and blank samples used to determine the correction factors.

(7) Boil Test. Perform the test and retain the tested sample from Tex-530-C. Use this sample for comparison purposes during production. The Engineer may waive the requirement for the boil test.

(8) Trial Batch Approval. Upon receiving conditional approval of JMF1 from the Engineer, provide a plant-produced trial batch for verification testing of JMF1 and development of JMF2.

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

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

(11) Number of Trial Batches. Produce trial batches as necessary to obtain a mixture that meets the requirements in Table 9.

(12) Trial Batch Sampling. Obtain a representative sample of the trial batch and split it into 3 equal portions in accordance with Tex-222-F. Label these portions as “Contractor,” “Engineer,” and “Referee.” Deliver samples to the appropriate laboratory as directed.

(13) Trial Batch Testing. Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the verification testing requirements for gradation, asphalt content, laboratory-molded density, and voids in mineral aggregates (VMA) listed in Table 9 and is in compliance with the Hamburg Wheel test requirement in Table 8. Use an approved laboratory to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

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

(15) Mixture Production. After receiving approval for JMF2 and receiving a passing result from the Department’s or an approved laboratory’s Hamburg Wheel test on the trial batch, use JMF2 to produce Lot 1 as described in Section 341.4.I.3.a(1), “Lot 1 Placement.” As an option, once JMF2 is approved, proceed to Lot 1 production at the Contractor’s risk without receiving the results from the Department’s Hamburg Wheel test on the trial batch.

If electing to proceed without Hamburg Wheel test results from the trial batch, notify the Engineer. Note that the Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor’s expense.

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

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

- be provided to the Engineer in writing before the start of a new lot,

- be numbered in sequence to the previous JMF,
- meet the master gradation limits shown in Table 6, and
- be within the operational tolerances of JMF2 listed in Table 9.

(18) Requesting Referee Testing. If needed, use referee testing in accordance with Section 341.4.I.1, "Referee Testing," to resolve testing differences with the Engineer.

Table 9
Operational Tolerances

Description	Test Method	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.	±5.0
Individual % retained for sieves smaller than #8 and larger than #200		±3.	±3.0
% passing the #200 sieve		±2.	±1.6
Asphalt content, %	Tex-236-F	±0.	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0
In-Place air voids, %		N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	±0.020
VMA, %, min		Note 4	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	±0.020

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

b. Engineer's Responsibilities.

(1) Gyratory Compactor. The Engineer will use a Department TGC, calibrated according to Tex-914-F, to mold samples for trial batch and production testing. The Engineer will make the Department TGC and the Department field laboratory available to the Contractor for molding verification samples, if requested by the Contractor.

(2) Conditional Approval of JMF1. Within 2 working days of receiving the mixture design report (JMF1) and all required materials and Contractor-provided Hamburg Wheel test results, the Engineer will review the Contractor's mix design report and verify conformance with all aggregates, asphalt, additives, and mixture specifications. The Engineer may perform tests to verify the aggregates meet the requirements listed in Table 1. The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test results with laboratory mixture design, a total of 10 working days is allowed for conditional approval of JMF1. Full approval of JMF1 will be based on the Engineer's test results on mixture from the trial batch.

(3) Hamburg Wheel Testing of JMF1. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the laboratory mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 8.

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

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

(6) Testing the Trial Batch. Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the gradation, asphalt content, laboratory-molded density, and VMA meet the requirements listed in Table 9. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 8.

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

- Tex-226-F to verify that the indirect tensile strength meets the requirement shown in Table 7;
- Tex-461-A to determine the need for additional magnesium sulfate soundness testing; 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 9.

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

(8) Approval of JMF2. The Engineer will approve JMF2 within 1 working day if it meets the master grading limits shown in Table 6 and is within the operational tolerances of JMF1 listed in Table 9.

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

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

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

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

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

2. Mixing and Discharge of Materials. Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The Department will not pay for or allow placement of any mixture produced at more than 350°F.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. If requested, determine the moisture content by oven-drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than

0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.

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

G. Placement Operations. Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 in. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly. Place mixture within the compacted lift thickness shown in Table 10 unless otherwise shown on the plans or allowed.

Table 10
Compacted Lift Thickness and Required Core Height

Mixture Type	Compacted Lift Thickness		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
A	3.00	6.00	2.00
B	2.50	5.00	1.75
C	2.00	4.00	1.50
D	1.50	3.00	1.25
F	1.25	2.50	1.25

1. **Weather Conditions.** Place mixture when the roadway surface temperature is 60°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

2. **Tack Coat.** Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at the rate directed by the Engineer. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a thin, uniform tack coat to all contact surfaces of curbs, structures, and all joints. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Roll the tack coat with a pneumatic-tire roller when directed. The Engineer may use Tex-243-F to verify that the tack coat has adequate adhesive properties. The Engineer may suspend paving operations until there is adequate adhesion.

3. **Lay-Down Operations.** Use the guidelines in Table 11 to establish the temperature of mixture delivered to the paver. Record the information on Department QC/QA forms and submit the forms to the Engineer.

   a. **Thermal Profile.** For each sublot, obtain a thermal profile using Tex-244-F. The Engineer may reduce the testing frequency based on a satisfactory test history. The Engineer may also obtain as many thermal profiles as deemed necessary. If the temperature differential is greater than 25°F, the area will be deemed as having thermal segregation. Evaluate areas with thermal segregation by performing a density profile in accordance with Section 341.4.I.3.c(2), "Segregation (Density Profile)." Take corrective action to eliminate areas that have thermal segregation. Unless otherwise directed, suspend operations if the maximum temperature differential exceeds 50°F. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Item.

   b. **Windrow Operations.** When hot mix is placed in windrows, operate windrow pickup equipment so that substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

Table 11
Suggested Minimum Mixture Placement Temperature

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

H. Compaction. Uniformly compact the pavement to the density requirements of this Item. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern. Do not use pneumatic-tire rollers if excessive pickup of fines by roller tires occurs. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment.

Where specific air void requirements are waived, furnish and operate compaction equipment as approved. Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with rollers. The Engineer may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

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

I. Acceptance Plan. Pay adjustments for the material will be in accordance with Article 341.6, “Payment.”

Sample and test the hot mix on a lot and sublot basis. If the production pay factor given in Section 341.6.A, “Production Pay Adjustment Factors,” for 3 consecutive lots or the placement pay factor given in 341.6.B, “Placement Pay Adjustment Factors,” for 3 consecutive lots is below 1.000, suspend production until test results or other information indicate to the satisfaction of the Engineer that the next material produced or placed will result in pay factors of at least 1.000.

1. Referee Testing. The Construction Division is the referee laboratory. The Contractor may request referee testing if a “remove and replace” condition is determined based on the Engineer’s test results, or if the differences between Contractor and Engineer test results exceed the maximum allowable difference shown in Table 9 and the differences cannot be resolved. 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 samples are received at the referee laboratory for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than 3 referee tests per project are required and the Engineer’s test results are closer than the Contractor’s test results to the referee test results.

The Construction Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory, and the Engineer’s average maximum theoretical specific gravity for the lot. With the exception of remove and replace conditions, referee test results are final and will establish pay adjustment factors for the sublot in question. Sublots subject to be removed and replaced will be further evaluated in accordance with Article 341.6, “Payment.”

2. Production Acceptance.

a. Production Lot. A production lot consists of 4 equal sublots. Lot 1 will be 1,000 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production. The lot size will be between 1,000 and 4,000 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 or the total production for the project is less than 5,000 tons, the Engineer may waive all quality control and quality assurance (QC/QA) sampling and testing requirements. If the Engineer waives QC/QA sampling and testing, both production and placement pay factors will be 1.000. However, the Engineer will retain the right to perform random acceptance tests for production and placement and may reject objectionable materials and workmanship.

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

- produce, haul, place and compact the mixture as directed by the Engineer;
- control mixture production to yield a laboratory-molded density of 96.0% ±1.0% as tested by the Engineer; and
- compact the mixture to yield in-place air voids that are greater than or equal to 2.7% and less than or equal to 9.9% as tested by the Engineer.

(2) Incomplete Production Lots. If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Adjust the payment for the incomplete lot in accordance with Section 341.6.A, “Production Pay Adjustment Factors.”

b. Production Sampling.

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

Obtain hot mix samples from trucks at the plant in accordance with Tex-222-F. For each sublot, take 1 sample at the location randomly selected. For each lot, the Engineer will randomly select and test a “blind” sample from at least 1 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 3 equal portions in accordance with Tex-200-F, and label these portions as “Contractor,” “Engineer,” and “Referee.” Deliver the samples to the appropriate party’s laboratory. Deliver referee samples to the Engineer. Discard unused samples after accepting pay adjustment factors for that lot.

(2) Asphalt Binder Sampling. Obtain a 1-qt. sample of the asphalt binder for each sublot of mixture produced. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill. Take the sample in accordance with the pipeline sampling procedure given in Tex-500-C, Part II. Label the can with the corresponding lot and 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 1 asphalt binder sample per project to verify compliance with Item 300, “Asphalts, Oils, and Emulsions.”

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

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

Table 12
Production and Placement Testing Frequency

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

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

d. Operational Tolerances. Control the production process within the operational tolerances listed in Table 9. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

(1) Gradation. Unless otherwise directed, suspend production when either the Contractor's or the Engineer's test results for gradation exceed the operational tolerances for 3 consecutive sublots on the same sieve or 4 consecutive sublots on any sieve. The consecutive sublots may be from more than 1 lot.

(2) Asphalt Content. No production or placement bonus will be paid for any lot that has 2 or more sublots within a lot that are out of operational tolerance for asphalt content based on either the Contractor's or the Engineer's test results. Suspend production and shipment of mixture if the asphalt content deviates from the current JMF by more than 0.5% for any 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 Hamburg Wheel tests on any areas of the roadway where rutting is observed. When the production or core samples fail the Hamburg Wheel test criteria in Table 8, suspend production until further Hamburg Wheel tests meet the specified values. Core samples, if taken, will be obtained from the center of the finished mat or other areas excluding the vehicle wheel paths. 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.

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

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

3. **Placement Acceptance.**

a. **Placement Lot.** A placement lot consists of 4 placement sublots. A placement sublot consists of the area placed during a production sublot.

(1) **Lot 1 Placement.** Placement bonuses for Lot 1 will be in accordance with Section 341.6.B, "Placement Pay Adjustment Factors." However, no placement penalty will be assessed for any sublot placed in Lot 1 when the in-place air voids are greater than or equal to 2.7% and less than or equal to 9.9%. Remove and replace any sublot with in-place air voids less than 2.7% or greater than 9.9%.

(2) **Incomplete Placement Lots.** An incomplete placement lot consists of the area placed as described in Section 341.4.I.2.a(2), "Incomplete Production Lot," excluding miscellaneous areas as defined in Section 344.4.I.3.a(4), "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production sublot.

(3) **Shoulders and Ramps.** Shoulders and ramps are subject to in-place air void determination and pay adjustments unless otherwise shown on the plans.

(4) **Miscellaneous Areas.** Miscellaneous areas include areas that are not generally subject to primary traffic such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous areas also include level-ups and thin overlays if the layer thickness designated on the plans is less than the compacted lift thickness shown in Table 10. Miscellaneous areas are not eligible for random placement sampling locations, and will receive a 1.000 placement pay factor. Compact areas that are not subject to in-place air void determination in accordance with Section 341.4.H, "Compaction."

b. **Placement Sampling.** At the beginning of the project, the Engineer will select random numbers for all placement sublots. The Engineer will provide the Contractor with the placement random numbers immediately after the sublot is completed. Mark the roadway location at the completion of each sublot and record the station number. Determine 1 random sample location for each placement sublot in accordance with Tex-225-F. If the randomly generated sample location is within 2 ft. of a joint or pavement edge, adjust the location by no more than necessary to achieve a 2-ft. clearance.

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

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

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

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

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

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

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

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

(2) Segregation (Density Profile). Test for segregation using density profiles in accordance with Tex-207-F, Part V. Provide the Engineer with the results of the density profiles as they are completed. Areas defined in Section 341.4.I.3.a(4), "Miscellaneous Areas," are not subject to density profile testing.

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

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

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

Table 13
Segregation (Density Profile) Acceptance Criteria

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

(3) Longitudinal Joint Density.

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

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

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

(4) Recovered Asphalt 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 DSR value of the extracted binder divided by the DSR value of the original unaged binder (including RAP binder). DSR values are obtained according to AASHTO T 315 at the specified high temperature PG of the asphalt. The binder from RAP will be included proportionally as part of the original unaged binder. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores using Tex-211-F.

(5) Irregularities. Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected. The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

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

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

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

341.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under Article 341.5, "Measurement," will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the type, surface aggregate classification, and binder specified. Pay adjustments for bonuses and penalties will be applied as determined in this Item. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals.

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

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

A. Production Pay Adjustment Factors. The production pay adjustment factor is based on the laboratory-molded density using the Engineer's test results. A pay adjustment factor will be determined from Table 14 for each sublot using the deviation from the target laboratory-molded density defined in Table 7. The production pay adjustment factor for completed lots will be the average of the pay adjustment factors for the 4 sublots sampled within that lot.

Table 14
Production Pay Adjustment Factors
for Laboratory-Molded Density

Absolute Deviation from Target Laboratory-Molded Density	Production Pay Adjustment Factor
0.0	1.050
0.1	1.050
0.2	1.050
0.3	1.044
0.4	1.038
0.5	1.031
0.6	1.025
0.7	1.019
0.8	1.013
0.9	1.006
1.0	1.000
1.1	0.965
1.2	0.930
1.3	0.895
1.4	0.860
1.5	0.825
1.6	0.790
1.7	0.755
1.8	0.720
> 1.8	Remove and replace

1. **Incomplete Production Lots.** Production pay adjustments for incomplete lots, described under Section 341.4.I.2.a(2), "Incomplete Production Lots," will be calculated using the average production pay factors from all sublots sampled. A production pay factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples.
2. **Production Sublots Subject to Removal and Replacement.** If after referee testing, the laboratory-molded density for any sublot results in a "remove and replace" condition as listed in Table 14, 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. The placement pay adjustment factor is based on in-place air voids using the Engineer's test results. A pay adjustment factor will be determined from Table 15 for each sublot that requires in-place air void measurement. A placement pay adjustment factor of 1.000 will be assigned to the entire sublot when the random sample location falls in an area on a ramp or shoulder not subject to in-place air void testing. A placement pay adjustment factor of 1.000 will be assigned to quantities placed in miscellaneous areas as described in Section 341.4.I.3.a(4), "Miscellaneous Areas." The placement pay adjustment factor for completed lots will be the average of the placement pay adjustment factors for the 4 sublots within that lot.

1. **Incomplete Placement Lots.** Pay adjustments for incomplete placement lots described under Section 341.4.I.3.a(2), "Incomplete Placement Lots," will be calculated using the average of the placement pay factors from all sublots sampled and sublots where the random location falls in an area on a ramp or shoulder not eligible for testing. A placement pay adjustment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples.
2. **Placement Sublots Subject to Removal and Replacement.** If after referee testing the placement pay adjustment factor for any sublot results in a "remove and replace" condition as listed in Table 15, the Engineer will choose the location of 2 cores to be taken within 3 ft. of the original failing core location. The Contractor will obtain the cores in the presence of the Engineer. The Engineer will submit the cores to the Materials and Pavements Section of the Construction Division where they will be tested for bulk specific gravity within 10 working days of receipt. The average bulk specific gravity of the cores will be divided by the Engineer's average maximum theoretical specific gravity for that lot to determine the new pay adjustment factor of the sublot in question. If the new pay adjustment factor is 0.700 or greater, then the new pay adjustment factor will apply to that sublot. If the new pay adjustment factor is less than 0.700, no payment will be made for the sublot. Remove and replace the failing sublot. Replacement material meeting the requirements of this Item will be paid for in accordance with this Article.

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

$TAP = (A+B)/2$

where:

A = Bid price × production lot quantity × average pay adjustment factor for the production lot
B = Bid price × placement lot quantity × average pay adjustment factor for the placement lot + (bid price × miscellaneous quantities × 1.000)

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

In-Place Air Voids	Placement Pay Adjustment Factor	In-Place Air Voids	Placement Pay Adjustment Factor
< 2.7	Remove and Replace	6.4	1.042
2.7	0.705	6.5	1.040
2.8	0.720	6.6	1.038
2.9	0.735	6.7	1.036
3.0	0.750	6.8	1.034
3.1	0.765	6.9	1.032
3.2	0.780	7.0	1.030
3.3	0.795	7.1	1.028
3.4	0.810	7.2	1.026
3.5	0.825	7.3	1.024
3.6	0.840	7.4	1.022
3.7	0.855	7.5	1.020
3.8	0.870	7.6	1.018
3.9	0.885	7.7	1.016
4.0	0.900	7.8	1.014
4.1	0.915	7.9	1.012
4.2	0.930	8.0	1.010
4.3	0.945	8.1	1.008
4.4	0.960	8.2	1.006
4.5	0.975	8.3	1.004
4.6	0.990	8.4	1.002
4.7	1.005	8.5	1.000
4.8	1.020	8.6	0.998
4.9	1.035	8.7	0.996
5.0	1.050	8.8	0.994
5.1	1.050	8.9	0.992
5.2	1.050	9.0	0.990
5.3	1.050	9.1	0.960
5.4	1.050	9.2	0.930
5.5	1.050	9.3	0.900
5.6	1.050	9.4	0.870
5.7	1.050	9.5	0.840
5.8	1.050	9.6	0.810
5.9	1.050	9.7	0.780
6.0	1.050	9.8	0.750
6.1	1.048	9.9	0.720
6.2	1.046	> 9.9	Remove and Replace
6.3	1.044		

APPENDIX E1

SECTION 315 A — ASPHALT CONCRETE PAVEMENT FOR LOW VOLUME AIRPORTS

SECTION 315 A — ASPHALT CONCRETE PAVEMENT FOR LOW VOLUME AIRPORTS
(changes to VDOT Section 315 are shown in italics)

315.0----Introduction

This Special Provision will describe the design, production, construction and acceptance of VDOT HMA mixtures in airport applications, such as taxiways, aprons and runways with Aircraft Gross Weight (AGW) of less than 60,000 pounds. It will revise VDOT Road and Bridge Specifications based on the Guidelines described in EB XXXXX – "Guidelines for Developing State Standard Airport Pavement (SSAP) Specifications".

It should be understood that the following terminology will be assumed to be synonymous throughout the referenced VDOT specifications 211 and 315 to make it applicable to standard airport specifications.

- *Department, synonymous with Airport Owner [or Owner Authorized Representative]*
- *Engineer, synonymous with Airport Owner [or Owner Authorized Representative]*
- *Roadway, synonymous with Airport Pavement*

315.01—Description.

This work shall consist of constructing one or more courses of asphalt concrete on a prepared foundation in accordance with the requirements of these specifications and within the specified tolerances for the lines, grades, thicknesses, and cross sections shown on the plans or as established by the Engineer.

315.02—Materials.

(a) **Asphalt concrete** shall conform to the requirements of Section 211, *except as outlined below*. If SUPERPAVE design densities begin to exceed 98 percent of the theoretical maximum density during construction, the Contractor shall alter the design.

Eliminate Section 211.01 and replace with the following:

211.01---Description

Asphalt Concrete shall consist of a combination of mineral aggregate and asphalt materials mixed mechanically in a plant specifically designed for such purpose.

The Aircraft Gross Weight, Traffic Level and location (taxiway/apron or runway) will be established by the Engineer and SUPERPAVE mix types may be specified as one of the types listed as follows:

VDOT Mixes for Airport Applications

Mix Type	*Traffic Level*	*Location*	*Pavement Layer*	*Aircraft Gross Weight, lbs.*	*Asphalt Binder Performance Grade*	*Aggregate Nom Max Size (in)* [1]
SM-9.5 A	*A, B*	*Taxiway, Apron & Runway*	*Leveling*	*<12,500 lbs 12,500 - <60,000 lbs*	*PG 64-22*	*3/8 in*
SM-12.5A	*A*	*Taxiway & Apron*	*Surface*	*<12,500 lbs*	*PG 64-22*	*½ in*
SM-12.5D	*B*	*Taxiway & Apron*	*Surface*	*12,500 - <60,000 lbs*	*PG 70-22*	*½ in*
SM-12.5 A	*A*	*Runway*	*Surface*	*<12,500 lbs*	*PG 64-22*	*½ in*
SM-12.5D	*B*	*Runway*	*Surface*	*12,500 - <60,000 lbs*	*PG 70-22*	*½ in*
IM-19.0A	*A*	*Taxiway & Apron*	*Intermediate, Base*	*<12,500 lbs*	*PG 64-22*	*¾ in*
IM-19.0D	*B*	*Taxiway & Apron*	*Intermediate, Base*	*12,500 - <60,000 lbs*	*PG 70-22*	*¾ in*
IM-19.0 A	*A*	*Runway*	*Intermediate, Base*	*<12,500 lbs*	*PG 64-22*	*¾ in*
IM-19.0D	*B*	*Runway*	*Intermediate, Base*	*12,500 - <60,000 lbs*	*PG 70-22*	*¾ in*

[1] Nominal maximum size is defined as one sieve size larger than the first sieve to retain more than 10% aggregate.

Asphalt concrete will conform to the requirements for the type designated, except for as revised in this document.

Eliminate Section 211.02 (j) 1 and replace with the following:

1. *Asphalt surface mixtures will contain a maximum of 15% by total aggregate weight of RAP. Asphalt intermediate and base mixtures will contain a maximum of 30% by total aggregate weight of RAP. Table II-14A will not be used.*

Revise Section 211.03 – Job Mix Formula as noted below:

211.03 (d) – replace Table II-13 with the following revised table.

TABLE II–13
Asphalt Concrete Mixtures: Design Range*[1]*

Mix Type	*Percentage by Weight Passing Square Mesh Sieves*									
	1 1/2 in	***1 in***	***3/4 in***	***1/2 in***	***3/8 in***	***No. 4***	***No. 8***	***No. 30***	***No. 50***	***No. 200***
SM-9.5 A				*100[2]*	*90–100*	*80 max.*	*52–67[3]*			*2–10*
SM-12.5 A,D			*100*	*95–100*	*90 max.*		*42–50[3]*			*2–10*
IM-19.0 A,D		*100*	*90–100*	*90 max.*			*38–49[3]*			*2–8*

1. *SM = Surface Mixture; IM = Intermediate Mixture.*
2. *A production tolerance of 1% will be applied to this sieve regardless of the number of tests in the lot.*
3. *Standard gradation tolerances on the No. 8 sieve have been revised to require the use of fine-graded asphalt concrete mixtures.*

211.03 (f) - eliminate requirements for rut testing during mix design by eliminating the second paragraph and the table referring to maximum rut depths.

Eliminate Section 211.05 and replace with the following:

211.05---Testing

The Engineer will provide the quality assurance (acceptance) testing necessary for the airport owner or his representative to determine conformance with the required grading, asphalt content and temperature properties for asphalt concrete. The Engineer's test results will be used for acceptance payment decisions.

The Contractor shall provide sufficient quality control (process control) testing and inspection at both the production plant and the roadway to ensure that the all operations and processes are conducted according to specifications. The Contractor will perform any tests necessary to ensure that the asphalt mixture being produced meets the requirements at the plant and on the roadway described in this specification. The Engineer will not use these test results in the acceptance payment decision. The Contractor will submit for approval a quality control plan that describes in detail how process control failures will be handled. The plan will describe the production process, testing equipment and/or sampling methods to determine the cause of the failure, and make any necessary changes to assure compliance with these specifications. The plan will also require the contractor to obtain a follow up sample immediately after corrective actions are taken to assess the adequacy of the corrections. In the event the follow-up process *control sample also fails to meet Specification requirements, the contractor will cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Engineer.*

The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. It shall be available for joint use by the Contractor for quality control testing and by the Engineer for acceptance testing and must have adequate equipment for the performance of the tests required by these specifications. The Engineer shall have priority in use of the equipment necessary for acceptance testing. The effective working area of the laboratory shall be a minimum of 150 square feet (14 square meters) with a ceiling height of not less than 7.5 feet (2.3 meters). Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70 degrees F + 5 degrees (21 degrees C + 2.3 degrees C). Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

The mixture will be accepted at the plant with respect to gradation (P_{-8} and P_{-200}), asphalt content (P_b), and volumetrics (volumetrics is defined as air voids at N_{design}). The mixture will be accepted on the roadway with respect to density of both mat and longitudinal joint according to the requirements of 315.05(e)--Density. Acceptance will be on a LOT-by-LOT basis (for each mix design) based on tests of random samples obtained within each sublot taken at a frequency of one set of samples per sublot. A roadway LOT and a plant production LOT shall be the same. All acceptance testing necessary to determine conformance with the acceptance requirements will be performed by the Engineer at no cost to the Contractor. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be calibrated by the testing organization prior to the start of operations. All Contractor personnel preparing laboratory compacted acceptance specimens shall be a state certified Superpave Mix Design Technician or equivalent acceptable to the Engineer.

The Engineer shall perform at least one test per day per mix on plant-produced asphalt concrete or per 1,000 tons of mix if more than 1,000 tons of mix is produced per day. In the event less than 300 tons of asphalt mixture is produced under a single job mix formula in a day, testing of the asphalt concrete will not be required. The tonnage will be added to subsequent production. When the accumulated tonnage exceeds 300 tons, minimum testing frequency shall apply.

Eliminate the first paragraph only of Section 211.06 and replace with the following:

211.06---Sampling and Testing

Aggregate gradation, asphalt content and mixture volumetrics will be determined from testing by the Engineer on samples of the loose mix. Samples of the plant produced asphalt concrete will be obtained from randomly selected haul trucks at the plant. The Engineer will obtain the plant samples at the frequency outlined above for sublot and lot testing. Samples will be obtained at the plant of a sufficient quantity to be split into two smaller samples; one for Quality Assurance (acceptance) testing by the Engineer and one for Referee testing; each sample at approximately 35 pounds. The split samples for Referee testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12” x 8” x 4”. Label and safely store these boxes in a manner agreed upon by the Engineer for possible future testing in case of a dispute as outlined in Section 211.10. The Contractor can retain additional split samples at their option.

In-place density will be determined from testing with a nuclear gauge according to 315. 05, e), 1, a by the Engineer taken from the completed roadway and areas adjacent to the roadway joints.

Revise Section 211.08 as outlined below:

211.08---Acceptance

Acceptance and pay adjustment will be made based on the Engineer's testing of samples taken at random locations obtained during plant production at the plant and on cores taken of both the roadway and joints from the compacted, in-place roadway.

Acceptance for gradation, asphalt content and volumetrics (air voids) of the plant-produced asphalt concrete will be based on the mean of the results of four tests performed on samples taken in a stratified random manner for each 2,000 ton lot (4,000 ton lots may be used when the normal daily production of the source from which the material is being obtained is in excess of 2,000 tons per day). Unless otherwise approved, samples shall be obtained from the approximate center of truckloads of material. In addition, four nuclear density tests will be taken for acceptance of in-place density of the roadway and another four nuclear density tests will be taken adjacent to the longitudinal joint for each lot. The lots and sublots for acceptance of testing on plant-produced material properties and on testing of in-place density will be the same. Sampling will be at randomly selected times or locations using any statistically acceptable method of randomization; however, the Department shall be advised of the method to be used prior to the beginning of production.

Should visual examination by the Engineer reveal that the material in any load or portion of the paved roadway is obviously contaminated or segregated, that load or portion of the paved roadway will be rejected without additional sampling or testing of the lot.

Delete Section 211.09 and replace with the following:

211.09---Adjustment System

Asphalt concrete will be accepted on a lot-by-lot basis using the Table II-15, Table II-16 and the composite pay factor equation shown below. An individual pay factor will be calculated for each property listed below using Table II-15, Table II-16 and Table II-17.

Table II-15: Acceptance Properties and Targets

Property	*Specification Limits*
Passing No. 8 sieve (percent)	*JMF Target*
Passing No. 200 sieve (percent)	*JMF Target*
Asphalt Content (percent)	*JMF Target*
Air Voids (percent)	*JMF Target*
Mat Density (percent of control strip density):	*98.0*
Joint Density (percent of control strip density):	*98.0*

Note: Section 315.05, e), 1, b density acceptance and pay factor is waived

Table II-16 Acceptance Tolerances

Tolerance for Each Laboratory Screen, Asphalt Content, Roadway Density and Joint Density Target: Percent Plus or Minus					
No. Tests	*No. 8*	*No. 200*	*Asphalt Content*	*Roadway Density*	*Joint Density*
1	*±8.0*	*±2.0*	*±0.60*	*-1.3*	*-1.3*
2	*±5.7*	*±1.4*	*±0.43*	*-1.0*	*-1.0*
3	*±4.4*	*±1.1*	*±0.33*	*-0.7*	*-0.7*
4	*±4.0*	*±1.0*	*±0.33*	*-0.5*	*-0.5*
8	*±2.8*	*±0.7*	*±0.2*	*-0.3*	*-0.3*

Table II-17 Adjustment Points for Each 0.1% of the Property Outside of the Acceptance Tolerance Permitted in Table II-16

Property	*Reductions in Pay Factor*
No. 8 Sieve	*0.1 %*
No. 200 Sieve	*0.3%*
Air Voids	*1.0*
Mat Density	*1.0*
Joint Density	*1.0*

A Composite Pay Factor (CPF) for the LOT will be calculated based on the individual Pay Factors (PF) with the following weighting applied: 30 percent Mat Density (D_m), 15 percent Joint Density (D_j), 20 percent Air Voids (V_a), 20 percent asphalt binder content (P_b), 10 percent Passing No. 200 (P_{-200}) and 5 percent Passing No. 8 (P_{-8}). Calculate the CPF by using the following formula:

$$CPF = [(0.300 \times PF\ D_m) + (0.150 \times D_j) + (0.200 \times PF\ V_a) + (0.200 \times PF\ P_b) + (0.100 \times PF\ P_{-200}) + (0.050 \times PF\ P_{-8})]$$

Note that the number after each multiplication will be rounded to the nearest 0.01. The pay adjustment shall be computed by multiplying the Composite Pay Factor for the LOT by the bid price per ton.

(b) **Asphalt for tack coat and prime coat** shall conform to the requirements of Section 310. Asphalt may be changed one viscosity grade by the Engineer at no change in the contract unit price.

(c) **Curb backup material** shall be asphalt concrete conforming to any surface or intermediate mixture listed in Table II-13 and Table II-14.

(d) **Liquid asphalt coating (emulsion) for rumble strip** shall conform to the requirements of Section 210.

315.03—Equipment.

(a) **Hauling Equipment:** Trucks used for hauling asphalt mixtures shall have tight, clean, smooth metal bodies equipped with a positive locking metal tailgate. Metal surfaces in contact with asphalt mixtures shall be given a thin coat of an aliphatic hydrocarbon invert emulsion release agent (nonpuddling), a lime solution, or other material on the Department's list of approved release agents. Except where a nonpuddling release agent is used, the beds of dump trucks shall be raised to remove excess agent prior to loading. Only a nonpuddling agent shall be used in truck beds that do not dump. Each truck shall be equipped with a tarpaulin or other cover that will protect the mixture from moisture and foreign matter and prevent the rapid loss of heat during transportation.

(b) **Asphalt Pavers:** The asphalt paver shall be designed and recommended by the manufacturer for the type of asphalt to be placed and shall be operated in accordance with the manufacturer's recommendations. Written recommendations pertaining to handling and placing the mix shall be made readily available on the project site to the Engineer. In the absence of the manufacturer's recommendations, the recommendations of the National Asphalt Pavement Association shall be followed. The paver, including when screed extensions are used, shall be capable of producing a smooth uniform texture, dense joints, and a smooth riding surface.

(c) **Rollers:** Rollers shall be steel wheel, static or vibratory, or pneumatic tire rollers and shall be capable of reversing without backlash. Rollers shall be operated at speeds slow enough to avoid displacement of the mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment that results in excessive crushing of aggregate or marring of the pavement surface will not be permitted.

If during construction the equipment being used mars the surface to the extent that imperfections cannot satisfactorily be corrected or produces permanent blemishes, the use of the equipment shall be discontinued and the equipment shall be replaced with satisfactory units.

(d) **Rotary Saw:** A gasoline-powered rotary saw with a carbide blade shall be furnished for cutting test samples from the pavement. The Contractor shall furnish gasoline, oil, additional carbide blades, and maintenance for the rotary saw. The Contractor shall cool the pavement prior to sawing the sample. In lieu of a rotary saw, the Contractor may furnish the necessary equipment for coring and testing 4-inch core samples in accordance with the requirements of VTM-22.

315.04—Placement Limitations.

Asphalt concrete mixtures shall not be placed when weather or surface conditions are such that the material cannot be properly handled, finished, or compacted. The surface upon which asphalt mixtures are to be placed shall be free of standing water, and the base temperature shall conform to the following:

(a) **When the base temperature is above 80 degrees F,** mixture laydown will be permitted at any temperature conforming to the limits specified in Section 211.

(b) **When the base temperature is between 40 degrees F and 80 degrees F,** the Nomograph, Table III-2, shall be used to determine the minimum laydown temperature of the asphalt concrete mixes. At no time should the minimum base and laydown temperatures be less than the following:

Mix Designation	Minimum Base Temperature	Minimum Laydown Temperature
A	40˚F	250˚F
D	50˚F	270˚F
E	50˚F	290˚F
M	50˚F	290˚F
S	50˚F	290˚F

The maximum temperature of the mixture shall conform to the requirements of Section 211.08.

(c) **When the laydown temperature is between 301 degrees F and 325 degrees F,** the number of compaction rollers will be the same number as required for 300 degrees F.

Intermediate and base courses that are placed at rates of application that exceed the application rates shown in Table III-2 shall conform to the requirements for the maximum application rate shown for 8-minute and 15-minute compaction rolling as per number of rollers used.

Should the Contractor be unable to complete the compaction rolling within the applicable 8-minute or 15-minute period, the placing of asphalt mixture shall either cease until sufficient rollers are used or other corrective action is taken to complete the compaction rolling within the specified period.

Compaction rolling shall be completed prior to the mat cooling down to 175 degrees F. Finish rolling may be performed at a lower mat temperature.

The final asphalt pavement finish course shall not be placed until construction pavement markings are no longer required.

315.05—Procedures.

(a) **Base Course:** The subgrade or subbase shall be prepared as specified in Section 305. The course upon which the pavement is to be placed, including the area that will support the paving equipment, shall be graded and compacted to the required profile.

(b) **Conditioning Existing Surface:** When the surface of the existing pavement or base is irregular, it shall be brought to a uniform grade and cross section as directed by the Engineer. The surface on which the asphalt concrete is to be applied shall be prepared in accordance with the requirements of the applicable specifications and shall be graded and compacted to the required profile and cross section.

When specified, prior to placement of asphalt concrete, longitudinal and transverse joints and cracks in hydraulic cement concrete shall be sealed by the application of an approved joint sealing compound.

Contact surfaces of curbing, gutters, manholes, and other structures projecting into or abutting the pavement and cold joints of asphalt shall be painted with a thick, uniform coating of asphalt prior to placement of asphalt mixture.

1. **Priming existing surface:** A tack or prime coat of asphalt shall be applied between the existing surface and each asphalt course placed thereafter. The tack or prime coat shall conform to the applicable requirements of Section 310 and Section 311.

   Asphalt classed as cutbacks or emulsions shall be applied ahead of the paving operations, and the time interval between applying and placing the paving mixture shall be sufficient to ensure a tacky residue providing maximum adhesion of the paving mixture to the base. The mixture shall not be placed on tack or prime coats that have been damaged by traffic or contaminated by foreign material. Traffic shall be excluded from such sections.

   On rich sections or those that have been repaired by the extensive use of asphalt patching mixtures, the tack coat shall be eliminated when directed by the Engineer.

   Priming: When asphalt concrete to be placed has a total thickness of 4 inches or more, priming with asphalt material will not be required on aggregate subbase or base material.

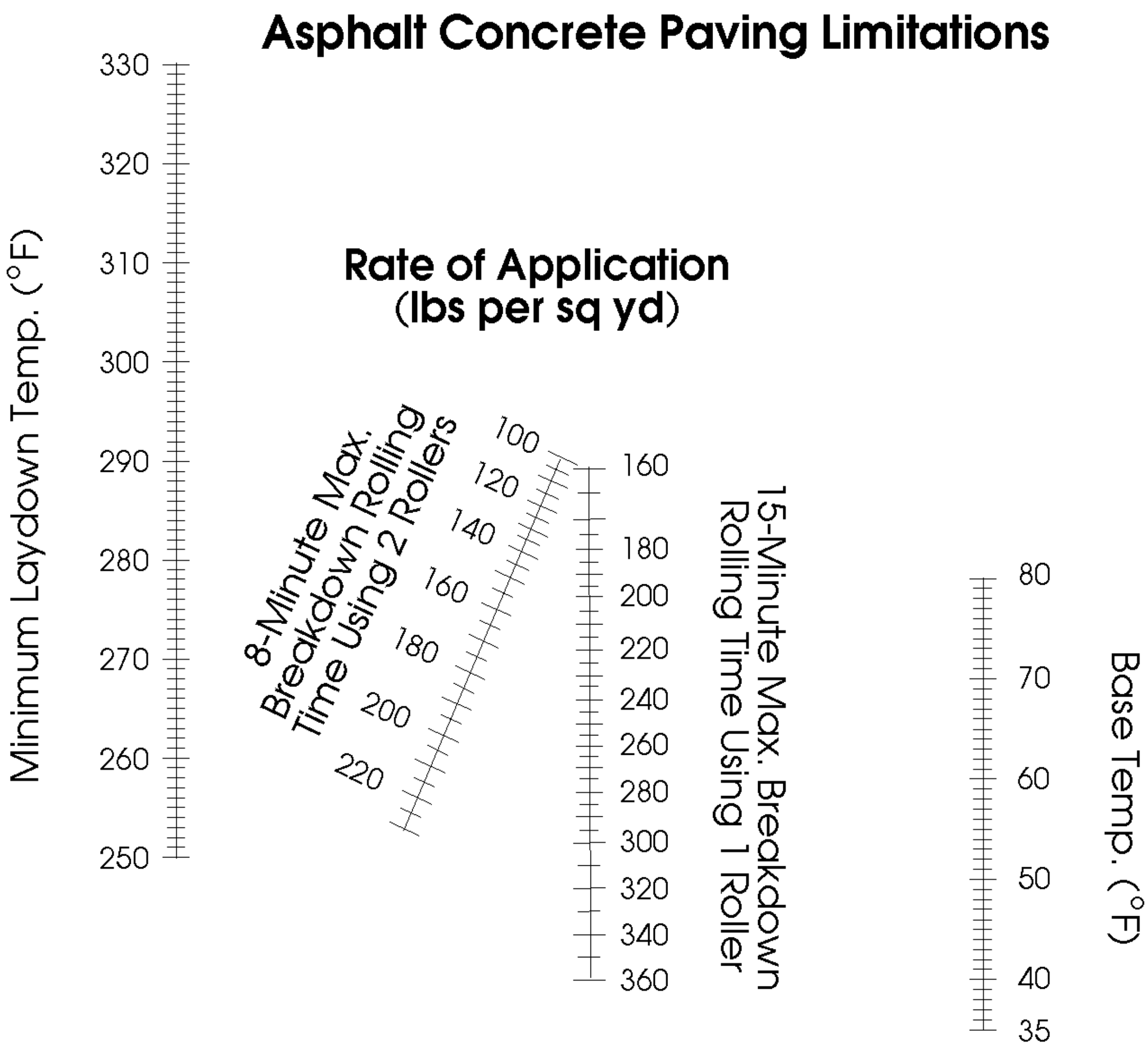
Tacking: Application of tack at joints, adjacent to curbs, gutters, or other appurtenances, shall be applied with a hand wand at the rate of 0.2 gallon per square yard. At joints, the tack applied by the hand wand shall be 2 feet in width with 4 to 6 inches protruding beyond the joint for the first pass. Tack for the adjacent pass shall completely cover the vertical face of the mat edge, so that slight puddling of asphalt occurs at the joint, and extend a minimum of 1 foot into the lane to be paved. Milled faces that are to remain in place shall be tacked in the same way for the adjacent pass. Use of tack at the vertical faces of longitudinal joints will not be required when paving in echelon.

2. **Removing depressions and elevating curves:** Where irregularities in the existing surface would result in a course more than 3 inches in thickness after compaction, the surface shall be brought to a uniform profile by patching with asphalt concrete and thoroughly tamping or rolling until it conforms with the surrounding surface. The mixture used shall be the same as that specified for the course to be placed.

   When the Contractor elects to conduct operations to eliminate depressions, elevate curves, and place the surface course simultaneously, he shall furnish such additional spreading and compacting equipment as required to maintain the proper interval between the operations.

TABLE III-2

Cold Weather Paving Limitations



(c) **Placing and Finishing:** Asphalt concrete shall not be placed until the surface upon which it is to be placed has been approved by the Engineer.

The edge of the pavement shall be marked by means of a continuous line placed and maintained a sufficient distance ahead of the paving operation to provide proper control of the pavement width and horizontal alignment.

An asphalt paver shall be used to distribute asphalt concrete over the widest pavement width practicable. Wherever practicable and when the capacity of sustained production and delivery is such that more than one paver can be operated, pavers shall be used in echelon to place the wearing course in adjacent lanes. Crossovers, as well as areas containing manholes or other obstacles that prohibit the practical use of mechanical spreading and finishing equipment, may be constructed using hand tools. However, care shall be taken to obtain the required thickness, jointing, compaction, and surface smoothness.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6 inches. However, the joint in the wearing surface shall be at the centerline of the pavement if the roadway comprises two traffic lanes or at lane lines if the roadway is more than two lanes in width. Offsetting layers will not be required when adjoining lanes are paved in echelon and the rolling of both lanes occurs within 15 minutes after laydown.

The Contractor shall have a certified Asphalt Field Technician present during paving operations. Immediately after placement and screeding, the surface and edges of each layer shall be inspected and straightedged by the technician and necessary corrections performed prior to compaction. The finished pavement shall be uniform and smooth.

The placement of asphalt concrete shall be as continuous as possible and shall be scheduled such that the interruption occurring at the completion of each day's work will not detrimentally affect the partially completed work. Material that cannot be spread and finished in daylight shall not be dispatched from the plant unless the use of artificial lighting has been approved. When paving is performed at night, sufficient light shall be provided to properly perform and thoroughly inspect every phase of the operation. Such phases include cleaning planed surfaces, applying tack, paving, compacting, and testing. Lighting shall be provided and positioned such as to not create a blinding hazard to the traveling public.

During compaction of asphalt concrete, the roller shall not pass over the end of freshly placed material except when a construction joint is to be formed. Edges shall be finished true and uniform.

Asphalt concrete SUPERPAVE pavement courses shall be placed in layers not exceeding 4.0 times the nominal maximum size aggregate in the asphalt mixture. The maximum thickness may be reduced if the mixture cannot be adequately placed in a single lift and compacted to the required uniform density and smoothness. The minimum thickness for a pavement course shall be no less than 2.5 times the nominal maximum size aggregate in the asphalt mixture. Nominal maximum size aggregate for each mix shall be defined as one sieve size larger than the first sieve to retain more than 10 percent aggregate as shown in the design range specified in Section 211.03, Table II-13. Base courses to be placed in irregularly shaped areas of pavement, such as transitions, turn lanes, crossovers, and entrances, may be placed in a single lift.

Overlays in excess of 165 pounds per square yard or with a milled depth greater than 1 1/2 inches shall be squared up prior to opening to traffic.

The milled roadway areas that are to be opened to traffic, excluding curb and gutter sections, shall have drainage outlets cut through the shoulder at locations designated by the Engineer. The Contractor shall plan and prosecute the milling operation to avoid the trapping of water on the roadway. Drainage outlets shall be restored to original grade, unless otherwise directed by the Engineer. The cost for cutting and restoring the drainage slots in the roadway shoulder shall be included in the price bid for other items of work.

The Contractor shall plan and prosecute a schedule of operations so that milled roadways will be overlaid with asphalt concrete as soon as possible. In no instance, shall the time lapse exceed 10 days after the milling operations, unless otherwise specified. The milled areas of the roadway shall be kept free of irregularities and obstructions that may create a hazard or annoyance to traffic in accordance with the requirements of Section 104.

A short ski or shoe shall be used to match the grade of the newly overlaid adjacent travel lane on primary, interstate, and designated secondary routes. Unless otherwise directed by the Engineer, a 24-foot minimum automatic grade control ski shall be used on asphalt mixtures on divided highways, with the exception of overlays that are less than full width and the first course of asphalt base mixtures over aggregate subbases. Care shall be exercised when working along curb and gutter sections to ensure a uniform grade and joint.

The Contractor shall construct the final riding surface to tie into the existing surface by an approved method, which shall include the cutting of a notch into the pavement. In addition to notching, the Contractor may use an asphalt design containing a fine-graded mix to achieve a smooth transition from the new asphalt concrete overlay to the existing pavement, with the approval of the Engineer. The material shall be of a type to ensure that raveling will not occur. The cost for constructing tie-ins in the asphalt concrete overlay shall be included in the price bid for asphalt concrete.

(d) **Compacting:** Immediately after the asphalt mixture is placed and struck off and surface irregularities are corrected, the mixture shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition. Rolling shall not cause undue displacement, cracking, or shoving.

The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

Immediately after the hot mixture is placed, it shall be sealed with rollers. Thereafter, rolling shall be a continuous process, insofar as practicable, and all parts of the pavement shall receive uniform compaction.

Rolling shall begin at the sides and proceed longitudinally parallel with the center of the pavement, each trip overlapping at least 1/2 the roller width, gradually progressing to the crown of the pavement. When abutting a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On superelevated curves, rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel with the centerline.

Displacements occurring as a result of reversing the direction of a roller or other causes shall be corrected at once by the use of rakes or lutes and addition of fresh mixture when required. Care shall be taken in rolling not to displace the line and grade of the edges of the asphalt mixture.

To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with a very small quantity of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons, or mechanical tampers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Edges of asphalt pavement surfaces shall be true curves or tangents. Irregularities shall be corrected.

The surface of the compacted course shall be protected until the material has cooled sufficiently to support normal traffic without marring.

(e) **Density:** Density shall be determined in accordance with the following:

1. The Contractor shall perform roller pattern and control strip density testing on surface, intermediate, and base courses in accordance with the requirements of VTM-76. The contractor shall have a certified Asphalt Field Technician perform all density testing.

   Density shall be determined by the backscatter method of testing using a thin-lift nuclear gage with printer, conforming to the requirements of VTM-81. Density test locations for the control strip and test sections shall be marked and labeled in accordance with the requirements of VTM-76. The Contractor shall furnish and operate the nuclear gage, which shall have been calibrated within the previous 12 months by an approved calibration service. In addition, the Contractor shall maintain documentation of such calibration service for a 12-month period. The required density of the compacted course shall be not less than 98.0 percent and not more than 102.0 percent of the target control strip density.

Nuclear density roller pattern and control strip density testing shall be performed on asphalt concrete overlays placed directly on surface treatment roadways and when overlays are placed at an application rate less than 125 pounds per square yard, based on 110 pounds per square yard per inch, on any surface. In these situations, sawed plugs or core samples will not be required and the minimum control strip densities as specified in Table III-3 will be waived. The required density of the compacted course shall be not less than 98.0 percent and not more than 102.0 percent of the target control strip.

TABLE III-3
Density Requirements

Mixture Type	Min. Control Strip Density (%)[1]
SM-9.5A, 12.5A	92.5
SM-9.5D, 12.5D	92.2
SM-9.5E, 12.5E	92.2
IM-19.0A	92.2
IM-19.0D	92.0
BM-25.0A, BM-25.0D	91.5

[1]The control strip density requirement is the percentage of theoretical maximum density of the job-mix formula by SUPERPAVE mix design or as established by the Engineer based on two or more production maximum theoretical density tests.

The project will be divided into "control strips" and "test sections" by the Engineer for the purpose of defining areas represented by each series of tests.

a. **Control Strip:** Control strips shall be constructed in accordance with the requirements of these specifications and VTM-76.

The term *control strip density* is defined as the average of 10 nuclear determinations selected at stratified random locations within the control strip.

One control strip shall be constructed at the beginning of work on each roadway and shoulder course and on each lift of each course. An additional control strip shall be constructed when a change is made in the type or source of materials or compaction equipment; whenever a significant change occurs in the composition of the material being placed from the same source; or when there is a failing control strip**.** During the evaluation of the initial control strip, paving operations may continue. However, paving and production shall be discontinued during construction and evaluation of additional control strips. In the event that two consecutive control strips fail, subsequent paving operations shall cease until corrective action(s) has been taken with the approval of the Engineer. If it is determined with the Engineer's approval that the density cannot be obtained because of the condition of the existing pavement structure, the target control strip density shall be determined from the roller pattern that achieves the optimum density and shall be used on the remainder of the roadway that exhibits similar pavement conditions.

Either the Engineer or Contractor may initiate an additional control strip at any time.

The length of the control strip shall be approximately 300 feet, regardless of the width of the course being placed. On the first day of construction or beginning of a new course, the control strip shall be started between 500 and 1,000 feet from the beginning of the paving operation. The control strip shall be constructed using the same paving, rolling equipment, procedures, and thickness as shall be used on the remainder of the course being placed.

One nuclear reading shall be taken at each of 10 stratified random locations. No determination shall be made within 12 inches of the edge of any application width for surface and intermediate mixes or within 18 inches of the edge of any application width for base mixes. The average of these 10 determinations shall be the control strip density recorded to the nearest 0.1 pound per cubic foot. The minimum control strip density shall be determined in accordance with the requirements of VTM-76.

The control strip shall be considered a lot. If the control strip density conforms to the requirements specified in Table III-3, the control strip will be acceptable and the control strip density shall become the target control strip density. If the density does not conform to the requirements specified in Table III-3, the tonnage placed in the control strip and any subsequent paving prior to construction of another control strip will be paid for in accordance with above section 211.09. The Contractor shall take corrective action(s) to comply with the density requirement specified in Table III-3.

Eliminate language related to the acceptance / pay factor of asphalt concrete.

(f) **Joints:** Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A coat of asphalt shall be applied to contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

Joints adjacent to curbs, gutters, or adjoining pavement shall be formed by hand placing sufficient mixture to fill any space left uncovered by the paver. The joint shall then be set up with rakes or lutes to a height sufficient to receive full compression under the rollers.

(g) ***Eliminate Language related to Rumble Strips.***

(h) **Saw-Cut Asphalt Pavement:** This work shall consist of saw-cutting the existing asphalt pavement to a depth shown on the plans and as directed by the Engineer.

315.06—Pavement Samples.

The Contractor shall cut samples from the compacted pavement for testing for depth and density. Samples shall be taken for the full depth of the course at the locations selected by the Engineer. The removed pavement shall be replaced with new mixture and refinished. No additional compensation will be allowed for furnishing test samples and reconstructing areas from which they were taken.

315.07—Pavement Tolerances.

Eliminate (a) Surface Tolerance and replace with the following:

(a) Surface Tolerance: *The finished surfaces of the pavement shall not vary more than 1/4 inch for the surface course. Each lot shall be evaluated with a 12-foot straightedge. The lot size shall be 2,000 square yards. Measurements will be made perpendicular and parallel to the centerline at distances not to exceed 50 feet. When 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area and replace with new material.*

Sufficient material shall be removed to allow at least two inches of asphalt concrete to be placed. Skin patching shall not be permitted. Isolated grinding of high points may be permitted in lieu of removal and replacement provided the total area of the high point is less than 15 square yards.

Eliminate (b) Finished Surface Tolerance, and replace with the following:

(b) ***Finished Grade Tolerance****: The finished surface of the pavement shall not vary from the grade line elevations and cross sections shown on the plans by more than 1/2 inch. The finished grade of each lot will be determined by running levels at intervals of 50 feet or less longitudinally and transversely to determine the elevation of the completed pavement. The lot size shall be 2,000 square yards. When more than 15 percent of all the measurements within a lot are outside the specified tolerance, the Contractor shall remove the deficient area and replace with new material. Sufficient material shall be removed to allow at least two inches of asphalt concrete to be placed. Skin patching for correcting low areas shall not be permitted. Isolated grinding of high points may be permitted in lieu of removal and replacement provided the total area of the high point is less than 15 square yards.*

If determined by the Engineer that either the finished grade elevations or cross slope exceed the tolerances specified, the Contractor shall submit to the Engineer for approval a plan of corrective action.

(c) **Thickness Tolerance:** The thickness of the base course will be determined by the measurement of cores as described in VTM-32B.

Acceptance of asphalt concrete base course for depth will be based on the mean result of measurements of samples taken from each lot of material placed. A *lot* of material is defined as the quantity being tested for acceptance except that the maximum lot size will be 1 mile of 24-foot-width base course.

A lot will be considered acceptable for depth if the mean result of the tests is within the following tolerance of the plan depth for the number of tests taken except that each individual test shall be within ±0.60 inch of the plan depth: mean of two tests, ±0.45 inch; mean of three tests, ±0.35 inch; mean of four tests, ±0.30 inch.

If an individual depth test exceeds the ±0.60-inch tolerance, that portion of the lot represented by the test will be excluded from the lot. If an individual test result indicates that the depth of material represented by the test is more than 0.60 inch, the Contractor will not be paid for that material in excess of the tolerance throughout the length and width represented by the test. If an individual test result indicates that the depth of the material represented by the test is deficient by more than 0.60 inch, correction of the base course represented by the test shall be made as specified hereinafter.

If the mean depth of a lot of material is excessive, the Contractor will not be paid for that material in excess of the tolerance throughout the length and width represented by the tests.

If the mean depth of a lot of material is deficient by more than the allowable tolerance, correction will not normally be required and the Contractor will be paid for the quantity of material that has been placed in the lot.

For excessive depth base courses, the rate of deduction from the tonnage allowed for payment as base course will be calculated at a weight of 115 pounds per square yard per inch of depth in excess of the tolerance. For sections of base course that are deficient in depth by more than 0.60 inch and less than 1.50 inch, the Contractor shall furnish and place material specified for the subsequent course to bring the base course depth within the tolerance. This material will be measured on the basis of tonnage actually placed, determined from weigh tickets, and paid for at the contract unit price for the base course material. Such material shall be placed in a separate course. If the deficiency is more than 1.50 inches, the Contractor shall furnish and place base course material to bring the base course thickness within the tolerance. Corrections for deficient base course depth shall be made in a manner to provide a finished pavement that is smooth and uniform.

When the Contract provides for the construction or reconstruction of the entire pavement structure, the surface and intermediate courses shall be placed at the rate of application shown on the plans within an allowable tolerance of ±5 percent of the specified application rate for application rates of 100 pounds per square yard or greater and within 5 pounds per square yard for application rates of less than 100 pounds per square yard. The amount of material exceeding the allowable tolerance will be deducted from the pay quantities.

When the Contract provides for the placement of surface or intermediate courses over existing pavement, over pavements constructed between combination curb and gutter, or in the construction or reconstruction of shoulders, such courses shall be placed at the approximate rate of application shown on the plans. However, the specified rate of application shall be altered where necessary to produce the required riding quality.

315.08—Measurement and Payment.

Asphalt concrete base will be measured in tons and paid for at the contract unit price per ton. This price shall include preparing and shaping the subgrade or subbase, constructing and finishing shoulders and ditches, and removing and replacing unstable subgrade or subbase.

Asphalt concrete will be measured in tons and paid for at the contract unit price per ton. Net weight information shall be furnished with each load of material delivered in accordance with the requirements of Section 211. Batch weights will not be permitted as a method of measurement unless the Contractor's plant is equipped in accordance with the requirements of Section 211, in which case the cumulative weight of the batches will be used for payment.

Asphalt used in the mixtures, when a pay item, will be measured in tons in accordance with the requirements of Section 109.01 except that transporting vehicles shall be tared prior to each load. The weight shall be adjusted in accordance with the percentage of asphalt indicated by laboratory extractions.

Tack coat shall be included in the price for other appropriate pay items.

Asphalt curb backup material will be measured in tons and will be paid for at the contract unit price per ton. This price shall include placing, tamping, and compacting.

Liquid asphalt cement, when a pay item, will be measured in tons and will be paid for at the contract unit price per ton.

Eliminate reference to rumble strips.

Saw-cut asphalt concrete pavement will be measured in linear feet for the depth specified and will be paid for at the contract unit price per foot, which price shall be full compensation for saw-cutting the asphalt pavement to the depth specified.

These prices shall include heat stabilization additive, furnishing samples, and maintaining traffic.

Payment will be made under:

Pay Item	**Pay Unit**
Asphalt concrete base course (Type)	Ton
Asphalt concrete (Type) (Class)	Ton
Asphalt concrete curb backup material	Ton
Liquid asphalt cement	Ton
Rumble strip (Asphalt)	Linear foot
Liquid asphalt coating (Rumble strips)	Square yard
Saw-cut asphalt concrete (depth)	Linear foot

APPENDIX E2

SECTION 315—ASPHALT CONCRETE PAVEMENT

SECTION 315—ASPHALT CONCRETE PAVEMENT

315.01—Description.

This work shall consist of constructing one or more courses of asphalt concrete on a prepared foundation in accordance with the requirements of these specifications and within the specified tolerances for the lines, grades, thicknesses, and cross sections shown on the plans or as established by the Engineer.

315.02—Materials.

(a) **Asphalt concrete** shall conform to the requirements of Section 211. If SUPERPAVE design densities begin to exceed 98 percent of the theoretical maximum density during construction, the Contractor shall alter the design.

(b) **Asphalt for tack coat and prime coat** shall conform to the requirements of Section 310. Asphalt may be changed one viscosity grade by the Engineer at no change in the contract unit price.

(c) **Curb backup material** shall be asphalt concrete conforming to any surface or intermediate mixture listed in Table II-13 and Table II-14.

(d) **Liquid asphalt coating (emulsion) for rumble strip** shall conform to the requirements of Section 210.

315.03—Equipment.

(a) **Hauling Equipment:** Trucks used for hauling asphalt mixtures shall have tight, clean, smooth metal bodies equipped with a positive locking metal tailgate. Metal surfaces in contact with asphalt mixtures shall be given a thin coat of an aliphatic hydrocarbon invert emulsion release agent (nonpuddling), a lime solution, or other material on the Department's list of approved release agents. Except where a nonpuddling release agent is used, the beds of dump trucks shall be raised to remove excess agent prior to loading. Only a nonpuddling agent shall be used in truck beds that do not dump. Each truck shall be equipped with a tarpaulin or other cover that will protect the mixture from moisture and foreign matter and prevent the rapid loss of heat during transportation.

(b) **Asphalt Pavers:** The asphalt paver shall be designed and recommended by the manufacturer for the type of asphalt to be placed and shall be operated in accordance with the manufacturer's recommendations. Written recommendations pertaining to handling and placing the mix shall be made readily available on the project site to the Engineer. In the absence of the manufacturer's recommendations, the recommendations of the National Asphalt Pavement Association shall be followed. The paver, including when screed extensions are used, shall be capable of producing a smooth uniform texture, dense joints, and a smooth riding surface.

(c) **Rollers:** Rollers shall be steel wheel, static or vibratory, or pneumatic tire rollers and shall be capable of reversing without backlash. Rollers shall be operated at speeds slow enough to avoid displacement of the mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment that results in excessive crushing of aggregate or marring of the pavement surface will not be permitted.

If during construction the equipment being used mars the surface to the extent that imperfections cannot satisfactorily be corrected or produces permanent blemishes, the use of the equipment shall be discontinued and the equipment shall be replaced with satisfactory units.

(d) **Rotary Saw:** A gasoline-powered rotary saw with a carbide blade shall be furnished for cutting test samples from the pavement. The Contractor shall furnish gasoline, oil, additional carbide blades, and maintenance for the rotary saw. The Contractor shall cool the pavement prior to sawing the sample. In lieu of a rotary saw, the Contractor may furnish the necessary equipment for coring and testing 4-inch core samples in accordance with the requirements of VTM-22.

315.04—Placement Limitations.

Asphalt concrete mixtures shall not be placed when weather or surface conditions are such that the material cannot be properly handled, finished, or compacted. The surface upon which asphalt mixtures are to be placed shall be free of standing water, and the base temperature shall conform to the following:

(a) **When the base temperature is above 80 degrees F,** mixture laydown will be permitted at any temperature conforming to the limits specified in Section 211.

(b) **When the base temperature is between 40 degrees F and 80 degrees F,** the Nomograph, Table III-2, shall be used to determine the minimum laydown temperature of the asphalt concrete mixes. At no time should the minimum base and laydown temperatures be less than the following:

Mix Designation	Minimum Base Temperature	Minimum Laydown Temperature
A	40˚F	250˚F
D	50˚F	270˚F
E	50˚F	290˚F
M	50˚F	290˚F
S	50˚F	290˚F

The maximum temperature of the mixture shall conform to the requirements of Section 211.08.

(c) **When the laydown temperature is between 301 degrees F and 325 degrees F,** the number of compaction rollers will be the same number as required for 300 degrees F.

Intermediate and base courses that are placed at rates of application that exceed the application rates shown in Table III-2 shall conform to the requirements for the maximum application rate shown for 8-minute and 15-minute compaction rolling as per number of rollers used.

Should the Contractor be unable to complete the compaction rolling within the applicable 8-minute or 15-minute period, the placing of asphalt mixture shall either cease until sufficient rollers are used or other corrective action is taken to complete the compaction rolling within the specified period.

Compaction rolling shall be completed prior to the mat cooling down to 175 degrees F. Finish rolling may be performed at a lower mat temperature.

The final asphalt pavement finish course shall not be placed until construction pavement markings are no longer required.

315.05—Procedures.

(a) **Base Course:** The subgrade or subbase shall be prepared as specified in Section 305. The course upon which the pavement is to be placed, including the area that will support the paving equipment, shall be graded and compacted to the required profile.

(b) **Conditioning Existing Surface:** When the surface of the existing pavement or base is irregular, it shall be brought to a uniform grade and cross section as directed by the Engineer. The surface on which the asphalt concrete is to be applied shall be prepared in accordance with the requirements of the applicable specifications and shall be graded and compacted to the required profile and cross section.

When specified, prior to placement of asphalt concrete, longitudinal and transverse joints and cracks in hydraulic cement concrete shall be sealed by the application of an approved joint sealing compound.

Contact surfaces of curbing, gutters, manholes, and other structures projecting into or abutting the pavement and cold joints of asphalt shall be painted with a thick, uniform coating of asphalt prior to placement of asphalt mixture.

1. **Priming existing surface:** A tack or prime coat of asphalt shall be applied between the existing surface and each asphalt course placed thereafter. The tack or prime coat shall conform to the applicable requirements of Section 310 and Section 311.

   Asphalt classed as cutbacks or emulsions shall be applied ahead of the paving operations, and the time interval between applying and placing the paving mixture shall be sufficient to ensure a tacky residue providing maximum adhesion of the paving mixture to the base. The mixture shall not be placed on tack or prime coats that have been damaged by traffic or contaminated by foreign material. Traffic shall be excluded from such sections.

   On rich sections or those that have been repaired by the extensive use of asphalt patching mixtures, the tack coat shall be eliminated when directed by the Engineer.

   Priming: When asphalt concrete to be placed has a total thickness of 4 inches or more, priming with asphalt material will not be required on aggregate subbase or base material.

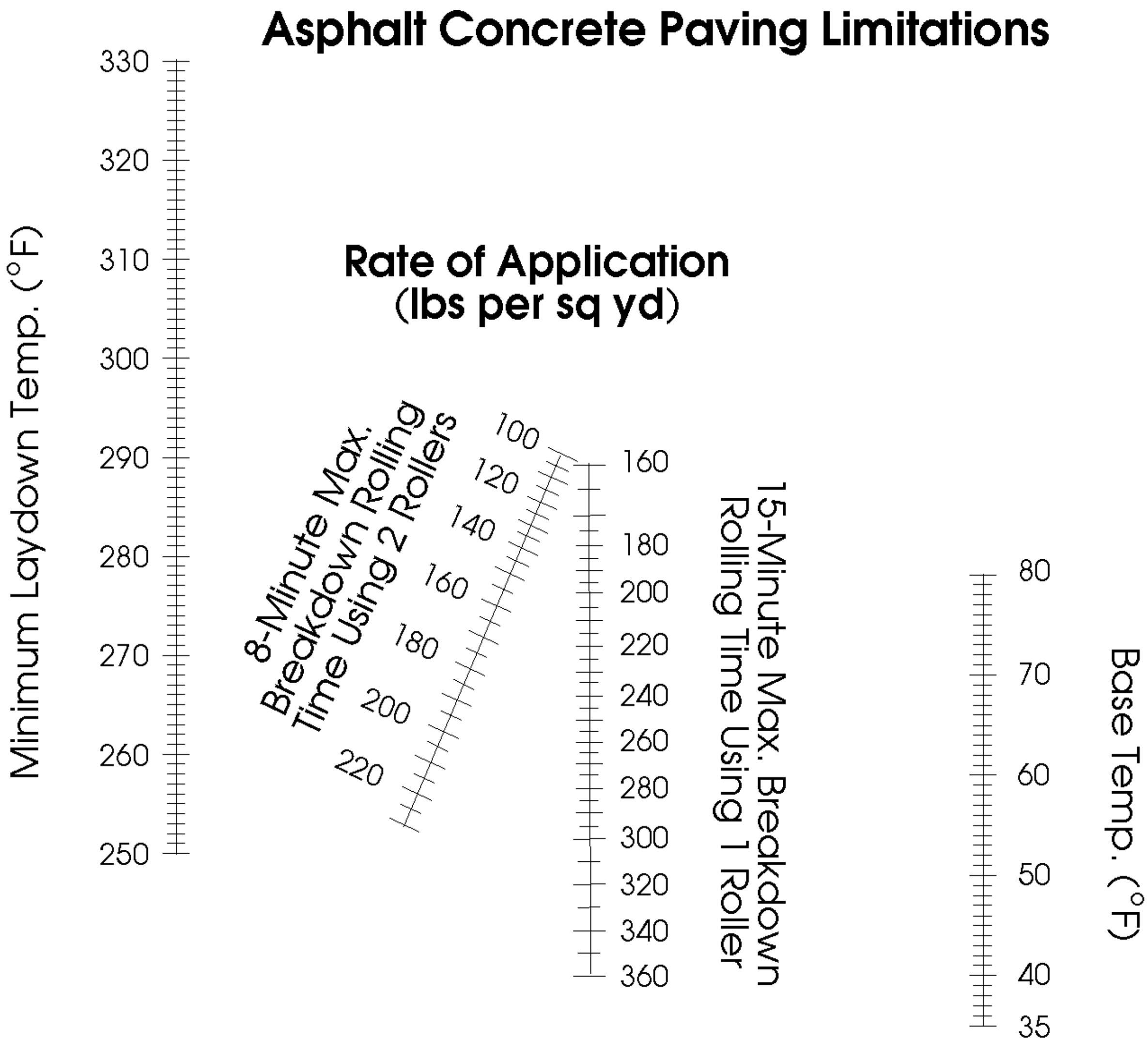
   Tacking: Application of tack at joints, adjacent to curbs, gutters, or other appurtenances, shall be applied with a hand wand at the rate of 0.2 gallon per square yard. At joints, the tack applied by the hand wand shall be 2 feet in width with 4 to 6 inches protruding beyond the joint for the first pass. Tack for the adjacent pass shall completely cover the vertical face of the mat edge, so that slight puddling of asphalt occurs at the joint, and extend a minimum of 1 foot into the lane to be paved. Milled faces that are to remain in place shall be tacked in the same way for the adjacent pass. Use of tack at the vertical faces of longitudinal joints will not be required when paving in echelon.

2. **Removing depressions and elevating curves:** Where irregularities in the existing surface would result in a course more than 3 inches in thickness after compaction, the surface shall be brought to a uniform profile by patching with asphalt concrete and thoroughly tamping or rolling until it conforms with the surrounding surface. The mixture used shall be the same as that specified for the course to be placed.

   When the Contractor elects to conduct operations to eliminate depressions, elevate curves, and place the surface course simultaneously, he shall furnish such additional spreading and compacting equipment as required to maintain the proper interval between the operations.

TABLE III-2

Cold Weather Paving Limitations



(c) **Placing and Finishing:** Asphalt concrete shall not be placed until the surface upon which it is to be placed has been approved by the Engineer.

The edge of the pavement shall be marked by means of a continuous line placed and maintained a sufficient distance ahead of the paving operation to provide proper control of the pavement width and horizontal alignment.

An asphalt paver shall be used to distribute asphalt concrete over the widest pavement width practicable. Wherever practicable and when the capacity of sustained production and delivery is such that more than one paver can be operated, pavers shall be used in echelon to place the wearing course in adjacent lanes. Crossovers, as well as areas containing manholes or other obstacles that prohibit the practical use of mechanical spreading and finishing equipment, may be constructed using hand tools. However, care shall be taken to obtain the required thickness, jointing, compaction, and surface smoothness.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6 inches. However, the joint in the wearing surface shall be at the centerline of the pavement if the roadway comprises two traffic lanes or at lane lines if the roadway is more than two lanes in width. Offsetting layers will not be required when adjoining lanes are paved in echelon and the rolling of both lanes occurs within 15 minutes after laydown.

The Contractor shall have a certified Asphalt Field Technician present during paving operations. Immediately after placement and screeding, the surface and edges of each layer shall be inspected and straightedged by the technician and necessary corrections performed prior to compaction. The finished pavement shall be uniform and smooth.

The placement of asphalt concrete shall be as continuous as possible and shall be scheduled such that the interruption occurring at the completion of each day's work will not detrimentally affect the partially completed work. Material that cannot be spread and finished in daylight shall not be dispatched from the plant unless the use of artificial lighting has been approved. When paving is performed at night, sufficient light shall be provided to properly perform and thoroughly inspect every phase of the operation. Such phases include cleaning planed surfaces, applying tack, paving, compacting, and testing. Lighting shall be provided and positioned such as to not create a blinding hazard to the traveling public.

During compaction of asphalt concrete, the roller shall not pass over the end of freshly placed material except when a construction joint is to be formed. Edges shall be finished true and uniform.

Asphalt concrete SUPERPAVE pavement courses shall be placed in layers not exceeding 4.0 times the nominal maximum size aggregate in the asphalt mixture. The maximum thickness may be reduced if the mixture cannot be adequately placed in a single lift and compacted to the required uniform density and smoothness. The minimum thickness for a pavement course shall be no less than 2.5 times the nominal maximum size aggregate in the asphalt mixture. Nominal maximum size aggregate for each mix shall be defined as one sieve size larger than the first sieve to retain more than 10 percent aggregate as shown in the design range specified in Section 211.03, Table II-13. Base courses to be placed in irregularly shaped areas of pavement, such as transitions, turn lanes, crossovers, and entrances, may be placed in a single lift.

Overlays in excess of 165 pounds per square yard or with a milled depth greater than 1 1/2 inches shall be squared up prior to opening to traffic.

The milled roadway areas that are to be opened to traffic, excluding curb and gutter sections, shall have drainage outlets cut through the shoulder at locations designated by the Engineer. The Contractor shall plan and prosecute the milling operation to avoid the trapping of water on the roadway. Drainage outlets shall be restored to original grade, unless otherwise directed by the Engineer. The cost for cutting and restoring the drainage slots in the roadway shoulder shall be included in the price bid for other items of work.

The Contractor shall plan and prosecute a schedule of operations so that milled roadways will be overlaid with asphalt concrete as soon as possible. In no instance, shall the time lapse exceed 10 days after the milling operations, unless otherwise specified. The milled areas of the roadway shall be kept free of irregularities and obstructions that may create a hazard or annoyance to traffic in accordance with the requirements of Section 104.

A short ski or shoe shall be used to match the grade of the newly overlaid adjacent travel lane on primary, interstate, and designated secondary routes. Unless otherwise directed by the Engineer, a 24-foot minimum automatic grade control ski shall be used on asphalt mixtures on divided highways, with the exception of overlays that are less than full width and the first course of asphalt base mixtures over aggregate subbases. Care shall be exercised when working along curb and gutter sections to ensure a uniform grade and joint.

The Contractor shall construct the final riding surface to tie into the existing surface by an approved method, which shall include the cutting of a notch into the pavement. In addition to notching, the Contractor may use an asphalt design containing a fine-graded mix to achieve a smooth transition from the new asphalt concrete overlay to the existing pavement, with the approval of the Engineer. The material shall be of a type to ensure that raveling will not occur. The cost for constructing tie-ins in the asphalt concrete overlay shall be included in the price bid for asphalt concrete.

(d) **Compacting:** Immediately after the asphalt mixture is placed and struck off and surface irregularities are corrected, the mixture shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition. Rolling shall not cause undue displacement, cracking, or shoving.

The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

Immediately after the hot mixture is placed, it shall be sealed with rollers. Thereafter, rolling shall be a continuous process, insofar as practicable, and all parts of the pavement shall receive uniform compaction.

Rolling shall begin at the sides and proceed longitudinally parallel with the center of the pavement, each trip overlapping at least 1/2 the roller width, gradually progressing to the crown of the pavement. When abutting a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On superelevated curves, rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel with the centerline.

Displacements occurring as a result of reversing the direction of a roller or other causes shall be corrected at once by the use of rakes or lutes and addition of fresh mixture when required. Care shall be taken in rolling not to displace the line and grade of the edges of the asphalt mixture.

To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with a very small quantity of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons, or mechanical tampers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Edges of asphalt pavement surfaces shall be true curves or tangents. Irregularities shall be corrected.

The surface of the compacted course shall be protected until the material has cooled sufficiently to support normal traffic without marring.

(e) **Density:** Density shall be determined in accordance with the following:

1. The Contractor shall perform roller pattern and control strip density testing on surface, intermediate, and base courses in accordance with the requirements of VTM-76. The contractor shall have a certified Asphalt Field Technician perform all density testing.

Density shall be determined by the backscatter method of testing using a thin-lift nuclear gage with printer, conforming to the requirements of VTM-81. Density test locations for the control strip and test sections shall be marked and labeled in accordance with the requirements of VTM-76. The Contractor shall furnish and operate the nuclear gage, which shall have been calibrated within the previous 12 months by an approved calibration service. In addition, the Contractor shall maintain documentation of such calibration service for a 12-month period. The required density of the compacted course shall be not less than 98.0 percent and not more than 102.0 percent of the target control strip density.

Nuclear density roller pattern and control strip density testing shall be performed on asphalt concrete overlays placed directly on surface treatment roadways and when overlays are placed at an application rate less than 125 pounds per square yard, based on 110 pounds per square yard per inch, on any surface. In these situations, sawed plugs or core samples will not be required and the minimum control strip densities as specified in Table III-3 will be waived. The required density of the compacted course shall be not less than 98.0 percent and not more than 102.0 percent of the target control strip.

TABLE III-3
Density Requirements

Mixture Type	Min. Control Strip Density (%)[1]
SM-9.5A, 12.5A	92.5
SM-9.5D, 12.5D	92.2
SM-9.5E, 12.5E	92.2
IM-19.0A	92.2
IM-19.0D	92.0
BM-25.0A, BM-25.0D	91.5

[1]The control strip density requirement is the percentage of theoretical maximum density of the job-mix formula by SUPERPAVE mix design or as established by the Engineer based on two or more production maximum theoretical density tests.

The project will be divided into "control strips" and "test sections" by the Engineer for the purpose of defining areas represented by each series of tests.

a. **Control Strip:** Control strips shall be constructed in accordance with the requirements of these specifications and VTM-76.

The term *control strip density* is defined as the average of 10 nuclear determinations selected at stratified random locations within the control strip.

One control strip shall be constructed at the beginning of work on each roadway and shoulder course and on each lift of each course. An additional control strip shall be constructed when a change is made in the type or source of materials or compaction equipment; whenever a significant change occurs in the composition of the material being placed from the same source; or when there is a failing control strip**.** During the evaluation of the initial control strip, paving operations may continue. However, paving and production shall be discontinued during construction and evaluation of additional control strips. In the event that two consecutive control strips fail, subsequent paving operations shall cease until corrective action(s) has been taken with the approval of the Engineer. If it is determined with the Engineer’s approval that the density cannot be obtained because of the condition of the existing pavement structure, the target control strip density shall be determined from the roller pattern that achieves the optimum density and shall be used on the remainder of the roadway that exhibits similar pavement conditions.

Either the Engineer or Contractor may initiate an additional control strip at any time.

The length of the control strip shall be approximately 300 feet, regardless of the width of the course being placed. On the first day of construction or beginning of a new course, the control strip shall be started between 500 and 1,000 feet from the beginning of the paving operation. The control strip shall be constructed using the same paving, rolling equipment, procedures, and thickness as shall be used on the remainder of the course being placed.

One nuclear reading shall be taken at each of 10 stratified random locations. No determination shall be made within 12 inches of the edge of any application width for surface and intermediate mixes or within 18 inches of the edge of any application width for base mixes. The average of these 10 determinations shall be the control strip density recorded to the nearest 0.1 pound per cubic foot. The minimum control strip density shall be determined in accordance with the requirements of VTM-76.

The control strip shall be considered a lot. If the control strip density conforms to the requirements specified in Table III-3, the control strip will be acceptable and the control strip density shall become the target control strip density. If the density does not conform to the requirements specified in Table III-3, the tonnage placed in the control strip and any subsequent paving prior to construction of another control strip will be paid for in accordance with Table III-4 on the basis of the percentage of the Table III-3 value achieved. The Contractor shall take corrective action(s) to comply with the density requirement specified in Table III-3.

TABLE III-4
Payment Schedule for Lot Densities

% of Target Control Strip Density	% of Payment
Greater than 102.0	95
98.0 to 102.0	100
97.0 to less than 98.0	95
96.0 to less than 97.0	90
Less than 96.0	75

b. **Test section (lot):** For the purposes of acceptance, each day’s production shall be divided into lots (test sections). The standard size of a lot shall be 5,000 linear feet of any pass made by the paving train regardless of the width of the pass of the thickness of the course. Pavers traveling in echelon will be considered as two passes. Each lot shall be divided into five sublots of equal length. When a partial lot occurs at the end of a day’s production or upon completion of the project, the lot size shall be redefined as follows: If the partial lot contains one or two sublots, the sublots will be added to the previous lot. If the partial lot contains three or four sublots, the partial lot will be redefined to be an entire lot. Each lot shall be tested for density by taking a nuclear density reading from two random locations selected by the Engineer within each sublot. Readings shall not be taken within 12 inches of the edge of any application width for surface and intermediate mixes or within 18 inches of the edge of any application width for base mixes. The average of the sublot nuclear density readings will be compared to the target nuclear control strip density to determine the acceptability of the lot. Once the average nuclear density of the lot has been determined, the Contractor will not be permitted to provide additional compaction to raise the average. If two consecutive sublots produce nuclear density results less than 98 percent or more than 102 percent of the target nuclear control strip density, the Contractor shall immediately notify the Engineer and institute corrective action. By the end of the day's operations, the Contractor shall furnish the test data developed during the day's paving to the Engineer.

The tonnage of each lot will be based on the lot's width and length and the mixture application rate as designated in the Contract or as revised by the Engineer. Payment will be made in accordance with the requirements of Table III-4.

The Engineer at any time on any project may perform lot density verification testing. Lot density verification can be performed by using either a nuclear gage or plugs. The Contractor shall be responsible for taking plugs for testing. Testing of the plugs will be done by or in the presence of the Engineer.

Surface, Intermediate, and Base mixes:

When a nuclear gage is used, the Engineer will take 10 stratified random readings per lot. If, based on the average of the 10 readings, the density does not meet the requirement for 100 percent pay or the same pay percentage determined by the Contractor's testing for that lot, the Engineer will take readings at the 10 Contractor sites and then average the readings of the 20 sites. If the density still does not conform to the requirements for 100 percent pay, payment for that lot will be in accordance with Table III-4 on the basis of the Engineer's average of the 20 test results. If the Contractor questions the payment for the lot, the Contractor can request the referee procedure.

The referee procedure shall consist of the Department taking five plugs from the five sites closest to the average of the Engineer's readings of the Contractor and Department sites. The density of the plugs will be determined. If the average density of the plugs does not conform to the requirements for 100 percent pay for the lot in question, payment for that lot will be in accordance with the specifications in Table III-4 on the basis of the percentage of the Table III-3 value achieved.

When plugs are used for lot density verification, five plugs shall be taken per lot. If the density of the plugs does not conform to the requirements for the lot in question, payment for that lot will be in accordance with the specifications in Table III-4 on the basis of the percentage of the Table III-3 value achieved.

2. **Surface, intermediate, and base courses** not having a sufficient quantity of material to run a nuclear density roller pattern and control strip shall be compacted to a minimum density of 91.5 percent of the theoretical maximum density as determined in accordance with the requirements of VTM-22. The Contractor shall be responsible for cutting cores or sawing plugs for testing by the Department. If the density is less than 91.5 percent, payment will be made in accordance with the requirements of Table III-5.

TABLE III-5

Payment Schedule for Surface, Intermediate and Base Courses (Not sufficient quantity to perform nuclear density roller pattern and control)

% TMD	% of Payment
Greater than 91.5	100
90.2-91.4	95
88.3-90.1	90
Less than 88.2	75

Any section in which a mixture (e.g., SM-9.0) is being placed at an application rate of less than 125 pounds per square yard, based on 110 pounds per square yard per inch, that does not have a sufficient quantity of material for a nuclear density roller pattern and control strip shall be compacted by rolling a minimum of three passes with a minimum 8-ton roller. No density testing will be required.

(f) **Joints:** Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A coat of asphalt shall be applied to contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

Joints adjacent to curbs, gutters, or adjoining pavement shall be formed by hand placing sufficient mixture to fill any space left uncovered by the paver. The joint shall then be set up with rakes or lutes to a height sufficient to receive full compression under the rollers.

(g) **Rumble Strips:** This work shall consist of constructing rumble strips on mainline shoulders of highways by cutting 1/2-inch-deep concave depressions into existing asphalt concrete surfaces as shown on the detail drawings and as directed by the Engineer.

Rumble strips shall be installed in accordance with detail drawings for rumble strips (asphalt shoulder). The depressions shall have a concave circular shape with a minimum 1/2-inch depth at center and maximum 5/8-inch allowable depth at center. Depressions shall have a smooth finish with a maximum 1/16-inch variance between peaks and valleys of the depression.

Prior to beginning production work on mainline shoulders, the Contractor shall demonstrate to the Engineer the ability to achieve the desired surface regarding alignment, consistency, and conformity with these specifications and the plans. The test site shall be approximately 25 feet longitudinally at a site mutually agreed upon by the Contractor and Engineer.

Following cutting and cleaning depressions of waste material, the entire rumble strip area shall be coated with liquid asphalt coating (emulsion) using a pressure distributor at an approximate rate of 0.1 gallon per square yard. Overspray shall not extend more than 2 inches beyond the width of the cut and/or shall not come in contact with pavement markings.

Rumble strips shall not be installed on shoulders of bridge decks, in acceleration/deceleration lanes, on surface drainage structures, or in other areas identified by the Engineer.

Waste material resulting from the operation shall be removed from the paved surface and shall not be disposed of where waterways may be at risk of contamination.

(h) **Saw-Cut Asphalt Pavement:** This work shall consist of saw-cutting the existing asphalt pavement to a depth shown on the plans and as directed by the Engineer.

315.06—Pavement Samples.

The Contractor shall cut samples from the compacted pavement for testing for depth and density. Samples shall be taken for the full depth of the course at the locations selected by the Engineer. The removed pavement shall be replaced with new mixture and refinished. No additional compensation will be allowed for furnishing test samples and reconstructing areas from which they were taken.

315.07—Pavement Tolerances.

(a) **Surface Tolerance:** The surface will be tested by using a 10-foot straightedge. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall be not more than 1/4 inch. Humps and depressions exceeding the specified tolerance shall be corrected or the defective work shall be removed and replaced with new material.

(b) **Finished Grade Tolerance**: After placement of the final pavement layer, finished grade elevations shall be within +/–0.04 foot of the elevations indicated in the plans, unless otherwise specified, provided that the actual cross slope does not vary more than 0.20 percent from the design cross slope indicated in the plans and the pavement thickness conforms to the thickness tolerances specified herein.

If determined by the Engineer that either the finished grade elevations or cross slope exceed the tolerances specified, the Contractor shall submit to the Engineer for approval a plan of corrective action.

(c) **Thickness Tolerance:** The thickness of the base course will be determined by the measurement of cores as described in VTM-32B.

Acceptance of asphalt concrete base course for depth will be based on the mean result of measurements of samples taken from each lot of material placed. A *lot* of material is defined as the quantity being tested for acceptance except that the maximum lot size will be 1 mile of 24-foot-width base course.

A lot will be considered acceptable for depth if the mean result of the tests is within the following tolerance of the plan depth for the number of tests taken except that each individual test shall be within ±0.60 inch of the plan depth: mean of two tests, ±0.45 inch; mean of three tests, ±0.35 inch; mean of four tests, ±0.30 inch.

If an individual depth test exceeds the ±0.60-inch tolerance, that portion of the lot represented by the test will be excluded from the lot. If an individual test result indicates that the depth of material represented by the test is more than 0.60 inch, the Contractor will not be paid for that material in excess of the tolerance throughout the length and width represented by the test. If an individual test result indicates that the depth of the material represented by the test is deficient by more than 0.60 inch, correction of the base course represented by the test shall be made as specified hereinafter.

If the mean depth of a lot of material is excessive, the Contractor will not be paid for that material in excess of the tolerance throughout the length and width represented by the tests.

If the mean depth of a lot of material is deficient by more than the allowable tolerance, correction will not normally be required and the Contractor will be paid for the quantity of material that has been placed in the lot.

For excessive depth base courses, the rate of deduction from the tonnage allowed for payment as base course will be calculated at a weight of 115 pounds per square yard per inch of depth in excess of the tolerance. For sections of base course that are deficient in depth by more than 0.60 inch and less than 1.50 inch, the Contractor shall furnish and place material specified for the subsequent course to bring the base course depth within the tolerance. This material will be measured on the basis of tonnage actually placed, determined from weigh tickets, and paid for at the contract unit price for the base course material. Such material shall be placed in a separate course. If the deficiency is more than 1.50 inches, the Contractor shall furnish and place base course material to bring the base course thickness within the tolerance. Corrections for deficient base course depth shall be made in a manner to provide a finished pavement that is smooth and uniform.

When the Contract provides for the construction or reconstruction of the entire pavement structure, the surface and intermediate courses shall be placed at the rate of application shown on the plans within an allowable tolerance of ±5 percent of the specified application rate for application rates of 100 pounds per square yard or greater and within 5 pounds per square yard for application rates of less than 100 pounds per square yard. The amount of material exceeding the allowable tolerance will be deducted from the pay quantities.

When the Contract provides for the placement of surface or intermediate courses over existing pavement, over pavements constructed between combination curb and gutter, or in the construction or reconstruction of shoulders, such courses shall be placed at the approximate rate of application shown on the plans. However, the specified rate of application shall be altered where necessary to produce the required riding quality.

315.08—Measurement and Payment.

Asphalt concrete base will be measured in tons and paid for at the contract unit price per ton. This price shall include preparing and shaping the subgrade or subbase, constructing and finishing shoulders and ditches, and removing and replacing unstable subgrade or subbase.

Asphalt concrete will be measured in tons and paid for at the contract unit price per ton. Net weight information shall be furnished with each load of material delivered in accordance with the requirements of Section 211. Batch weights will not be permitted as a method of measurement unless the Contractor's plant is equipped in accordance with the requirements of Section 211, in which case the cumulative weight of the batches will be used for payment.

Asphalt used in the mixtures, when a pay item, will be measured in tons in accordance with the requirements of Section 109.01 except that transporting vehicles shall be tared prior to each load. The weight shall be adjusted in accordance with the percentage of asphalt indicated by laboratory extractions.

Tack coat shall be included in the price for other appropriate pay items.

Asphalt curb backup material will be measured in tons and will be paid for at the contract unit price per ton. This price shall include placing, tamping, and compacting.

Liquid asphalt cement, when a pay item, will be measured in tons and will be paid for at the contract unit price per ton.

Rumble strips will be measured and paid for in linear feet of shoulder where the rumble strips are actually placed and accepted, excluding the test site. This distance will be measured longitudinally along the edge of pavement with deductions for bridge decks, acceleration/deceleration lanes, surface drainage structures, and other sections where the rumble strips are not installed. This price shall be full compensation for application; disposal of waste material; and all labor, tools, equipment, and incidentals necessary to complete the work. The test site will not be measured for payment but shall be included in the unit price for rumble strip.

Liquid asphalt coating (rumble strips) will be measured and paid for in square yards as described herein. This price shall be full compensation for cleaning rumble strips prior to application of the coating; furnishing and applying coating as specified herein; and all labor, tools, equipment, and incidentals necessary to complete the work.

Saw-cut asphalt concrete pavement will be measured in linear feet for the depth specified and will be paid for at the contract unit price per foot, which price shall be full compensation for saw-cutting the asphalt pavement to the depth specified.

These prices shall include heat stabilization additive, furnishing samples, and maintaining traffic.

Payment will be made under:

Pay Item	**Pay Unit**
Asphalt concrete base course (Type)	Ton
Asphalt concrete (Type) (Class)	Ton
Asphalt concrete curb backup material	Ton
Liquid asphalt cement	Ton
Rumble strip (Asphalt)	Linear foot
Liquid asphalt coating (Rumble strips)	Square yard
Saw-cut asphalt concrete (depth)	Linear foot

APPENDIX F1

State Test Case #6, California:

Caltrans SECTION 39A

Airport Pavement for <60,000# AGW

AAPTP 06-05 California Example of SSAP Specification.

[Note to the Engineer:

1) **The most recent version of Caltrans Standard Specifications can be found at http://www.dot.ca.gov/hq/esc/oe/specifications/std_specs/2006_StdSpecs/2006_StdSpecs.doc**
   SECTION 39 "Hot Mix Asphalt" of the Caltrans Standard Specifications was completely rewritten, and the new version issued on 03-21-08.
2) **Other SECTIONS of the Caltrans Standard Specifications relevant to the proper execution of SECTION 39 "Hot Mix Asphalt" are;**
   a. **SECTIONS 1 through 9 (General Provisions),**
   b. **SECTION 37-1 (Seal Coats),**
   c. **SECTION 42 (Groove and grind pavement),**
   d. **SECTION 88 (Engineering Fabrics),**
   e. **SECTION 92 (Asphalts),**
   f. **SECTION 93 (Liquid Asphalts), and**
   g. **SECTION 94 (Asphaltic Emulsions).**
3) **The companion document for the Caltrans Standard Specifications is the Caltrans Construction Manual. This manual can be found at http://www.dot.ca.gov/hq/construc/manual2001/cmsep2007_bookmarks.pdf**
   Appendix 1 of this Construction Manual contains the sample forms referenced in SECTION 39.
4) **The selection of asphalt binder grade is documented in Table 632.1 on page 630-4 of the Caltrans Highway Design Manual. This Manual can be found at http://www.dot.ca.gov/hq/oppd/hdm/pdf/english/chp0630.pdf**
5) **Standard Special Provisions (SSPs) for specifying specific items can be found at http://www.dot.ca.gov/hq/esc/oe/specifications/SSPs/2006-SSPs/SSPIndex/2006_Index.doc**

Noteworthy items regarding the Caltrans Standard Specifications which affect this example SSAP are as follows:

6) **SECTION 39 refers to the Hveem method of mix design to establish the job mix formula (JMF).**
7) **SECTION 39 contains three (3) levels of project specifications:**
   a. **Standard Specification (typically for <10,000 tonnes of HMA projects)**
   b. **Method Specification (typically for small/repair type projects)**
   c. **Quality Control/Quality Assurance (QC/QA) Specification (typically for >10,000 tonnes)**
8) **SECTION 39 refers to HMA mix Types A and B. This relates to the aggregate qualities and mix design requirements. Caltrans specifies a mix by; aggregate size, mix type, and binder grade. For example; "19-mm Type A, PG 64-10". In this SSAP a HMA will therefore be specified as follows: "1.0 in. MAS Type A, PG 64-10".]**

Caltrans SECTION 39A; Hot Mix Asphalt (HMA) Airport Pavement for <60,000 lbs. Aircraft Gross Weight (AGW)

SECTION 39, and all other referenced SECTIONS of the Standard Specifications issued by the California Department of Transportation (Caltrans), current edition, are applicable under this SECTION 39A, except as modified herein.

In SECTION 1 "Definitions and Terms", and in all other SECTIONS of the Caltrans Standard Specifications and related Documents, equivalent terminology is as follows:

- The Department, synonymous with Airport Owner [or Owner Authorized Representative]
- Director, synonymous with the Airport Manager (or CEO)
- Engineer, synonymous with Airport Owner [or Owner Authorized Representative]
- Laboratory, synonymous with the Laboratory retained by the Airport Owner
- Offices of Structure Design, synonymous with the Engineering Firm or Department
- Roadway/Traveled Way, synonymous with Airport Pavement.
- The Special Provisions, synonymous with the project specifications.

In addition:

- Airside pavements are all pavements traveled by aircraft
- Landside pavements are all pavements not traveled by aircraft (typically pavements located outside of the security fence).

SECTION 39-1 "GENERAL"

In 39-1.01; delete the HMA types; 3) Open graded friction course (OGFC), rubberized hot mix asphalt (open graded) (RHMA-O), and rubberized hot mix asphalt (open graded high binder) (RHMA-O-HB), and 4) Rubberized hot mix asphalt (gap graded) (RHMA-G). Delete in the rest of SECTION 39 all text related to these four mix types; OGFC, RHMA-O, RHMA-O-HB, and RHMA-G.

In 39-1.01; add;

- Airside pavements for Aircraft with AGW <12,500 lbs shall be constructed using Type A or Type B mix, and the Standard Specification.
- Airside pavements for Aircraft with AGW >12,500 lbs (but less than 60,000 lbs) shall be constructed using Type A mix, and the QC/QA Specification.
- Landside pavements shall be constructed using Type A or Type B mix, and the Standard Specification.
- For small repair work (Airside and Landside) the Method Specification shall be used.

In 39-1.02C; delete the reference to SECTION 39-1.02D, "Asphalt Rubber Binder".

In 39-1.02C; add: Use the Caltrans Highway Design Manual (HDM), Table 632.1 "Asphalt Binder Grade"
(page 630-4), column for Dense Graded HMA – Special, to select the PG grade for the project.
This can be found at http://www.dot.ca.gov/hq/oppd/hdm/pdf/english/chp0630.pdf

39-1.02D; delete completely.

In 39-1.02E; replace all Aggregate Gradation Tables with the following Aggregate Gradation Table.

[Note to the Engineer:
The aggregate gradation must be specified from Aggregate Gradation Table below. The gradations are defined by maximum aggregate size (MAS), which is the sieve size that is one size larger than the first sieve to retain material. The aggregate gradation bands are from the FAA P-401 and P-403 specifications and provide a 1½-inch, 1.0-inch, ¾-inch, and ½-inch MAS. The 1½-inch MAS (from P-403) is normally reserved for base course layers while the ½-inch MAS (from P-403) is primary used as a leveling material for very thin lifts. The ¾-inch MAS and the 1-inch MAS (from P-401 and P-403) are the dominant aggregate gradations used for surface and base course mixes respectively.]

Aggregate Gradation Table

Sieve Size	All Pavements			
	Percent by Weight Passing Sieves			
	1 1/2 in MAS	1.0 in. MAS	3/4 in. MAS	1/2 in. MAS
1.5 in.(37.5 mm)	100	100	100	100
1.0 in.(25.0 mm)	86 to 98	100	100	100
¾ in.(19.0 mm)	68 to 93	76 to 98	100	100
½ in.(12.5 mm)	57 to 81	66 to 86	79 to 99	100
⅜ in.(9.5 mm)	49 to 69	57 to 77	68 to 88	79 to 99
No. 4(4.75 mm)	34 to 54	40 to 60	48 to 68	58 to 78
No. 8(2.36 mm)	22 to42	26 to 46	33 to 53	39 to 59
No. 16(1.18 mm)	13 to 33	17 to 37	20 to 40	26 to 46
No. 30(0.600 mm)	8 to 24	8 to 24	14 to 30	19 to 35
No. 50 (0.300 mm)	6 to 18	4 to 12	9 to 21	12 to 24
No. 100(0.150 mm)	4 to 12	6 to 16	6 to 16	7 to 17
No. 200 (0.075 mm)	3 to 6	3 to 6	3 to 6	3 to 6

39-1.04C; delete completely.

39-1.06; For dispute resolution, the Independent Third Party (ITP) will be chosen by the Engineer. The ITP shall be AASHTO and/or Caltrans accredited.

39-1.07; Use the first sublot of 680 tonnes as a Test strip. Pave two lanes and evaluate the longitudinal joint quality. The Test strip needs to demonstrate that the rest of the project will meet the project specifications. The Test strip is only required for Airside projects using the QC/QA Specification.

39-1.08C; delete completely.

39-1.09D; delete:

1. Repair cracks 6 mm and wider, spalls, and holes in the pavement. The State pays for this repair work under Section 4-1.03D, “Extra Work”, and replace it with:
1. Repair cracks 6 mm and wider, spalls, and holes in the pavement. The cost for this item is considered incidental to the placement of the Geosynthetic Pavement Interlayer.

39-1.09D; The minimum HMA thickness over the interlayer must be 65 mm thick.

[Note to the Engineer:
Only use Geosynthetic Pavement Interlayer (Engineering Fabric) where appropriate. Its function is to delay reflection cracking, not to correct structural problems. If improperly installed delamination and/or slippage may occur.]

39-1.11; For Airside pavements, longitudinal joints shall have offsets with the lower layer of at least 0.30 m. Transvers joints in adjacent paving lanes shall be offset a minimum of 3.0m. Areas of segregation, as determined by the Engineer, shall be removed and replaced at the Contractor’s expense.

39-1.11; delete: Spread and compact HMA under Section 39-3.03, “Spreading and Compacting Equipment,” and Section 39-3.04, “Transporting, Spreading, and Compacting,” if either:

1. Total paved thickness is less than 45 mm.
2. Total paved thickness is less than 60 mm and a 19-mm aggregate grading is specified and used.
3. You spread and compact at:
   3.1 Asphalt concrete surfacing replacement areas
   3.2 Leveling courses
   3.3 Detours not included in the final roadway prism
   3.4 Areas the Engineer determines conventional compaction and compaction measurement methods are impeded.

And replace it with: Spread and compact HMA under Section 39-3.03, “Spreading and Compacting Equipment,” and Section 39-3.04, “Transporting, Spreading, and Compacting,” if:

You spread and compact at:
1 Leveling courses
2 Detours not included in the final roadway prism
3 Areas the Engineer determines conventional compaction and compaction measurement methods are impeded.

39-1.11; add: **Joints**. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade. Longitudinal joints which are irregular, damaged, uncompacted, or otherwise defective (or which have been left exposed for more than 4 hours, or whose surface temperature has cooled to less than 160 F) shall be cut back sufficiently (but no more than 0.15 m) to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be cleaned and dry prior and given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The cost of this work and tack coat shall be considered incidental to the cost of the bituminous course. A joint lot relates to the pavement lot that crated the joint (the second paving lane of two adjacent paving lanes). One core shall be taken by the Contractor from each sublot. Core locations will be determined by the Engineer on a random basis in accordance with ASTM D 3665. All coring shall be centered on the joint. The minimum core diameter for joint density determination shall be 5 inches.

39-1.11; add: **Skid resistant surfaces/saw-cut grooving.** If shown on the plans, skid resistant surfaces for asphalt pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving.
Transvers grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1.5 inches center to center configuration. The grooves shall be continuous for the entire length of the pavement. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for the saw-cut grooves shall meet the following:

a. Alignment tolerance – Plus or minus 1.5 inches in alignment for 75 feet.
b. Groove tolerance – Minimum depth 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch deep. Maximum groove depth is 5/16 inch. Minimum groove width is ¼ inch. Maximum groove width is 5/16 inch.
c. Center to center spacing – Minimum spacing is 1-3/8 inches. Maximum spacing is 1-5/8 inches.

Grooves shall not be less than 6 inches and not more than 18 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with governing laws and regulations, and as stated in SECTION 42 (Groove and grind pavement) of the Caltrans Standard Specifications. All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

39-1.12A; change the first sentence to: Determine HMA smoothness with a straightedge or a profilograph.

39-1.12B; For projects under Standard Specification and QC/QA Specification add: Smoothness measurements shall be made transversely at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made along the center of each paving lane. When more than 15 percent of all measurements exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material, when directed by the Engineer. Skin patching shall not be permitted. Isolated high points may be permitted upon the Engineer's approval.

39-1.12C; There is no need to report the profilograph results to: Smoothness@dot.ca.gov

[Note to the Engineer:
If smoothness measurements by straightedge is considered sufficient, then delete 39-1.12C completely. For the Method Specification smoothness measurements may not be applicable.]

39-1.14; delete completely.

39-2 "STANDARD Specification"

39-2.03A; In the "Reduced Payment Factors for Percent of Maximum Theoretical Density (%TMD, or %Gmm)", change the numbers in the left side column (Percent of Maximum Theoretical Density) from 91.0 to 92.8, and 90.9 to 92.7, etc., etc., down to <89.0 becomes <90.8.
This Reduced Payment Factors Table applies to surface courses, HMA base courses, and the joint densities, with the exception that for joint densities the Reduced Payment Factors for %TMD densities of 97.0 and greater do not apply.

39-2.03A; A joint lot relates to the pavement lot that crated the joint (the second paving lane of two adjacent paving lanes), and its Reduced Payment Factor applies to that pavement lot in addition to any mat related reduced payment.

39-3 "METHOD Specification"

39-3.04; In the Minimum Atmospheric and Surface Temperatures Table: make the correction; degrees F should be degrees C.
39-3.04; add: The compaction process needs to be acceptable to the Engineer.
29-3.04; add: The joints have to be acceptable to the Engineer. If the joints are not acceptable, remedial action shall be taken as directed by the Engineer. The cost for this remedial action is considered incidental to the HMA unit price.

39-4 "QC/QA Specification"

39-4.02; change: 1. 20 sublots are completed, to: 1. 6 sublots are completed.

39-4.02; Each lot consists of no more than 6 sublots.

39-4.03C; In the Minimum Quality Control – QC/QA Table, change for both Type A and Type B the Percent of maximum theoretical density to: 93 – 96.5

39-4.03F; delete: The Engineer grants a waiver and you must use 1.0 as the individual quality factor for percent of maximum theoretical density, QFQC5, for HMA paved in:
1. Areas where the total paved thickness is less than 45 mm
2. Areas where the total paved thickness is less than 60 mm and a 19-mm grading is specified and used
3. Dig outs
4. Leveling courses

Replace this with: The Engineer grants a waiver and you must use 1.0 as the individual quality factor for percent of maximum theoretical density, QFQC5, for HMA paved in:
1. Dig outs
2. Leveling courses
3. etc.

39-4.05A; In the HMA Acceptance – QC/QA Table, change for both Type A and Type B the Percent of maximum theoretical density to: 93 – 96.5

39-4.05B; A joint lot relates to the pavement lot that crated the joint (the second paving lane of two adjacent paving lanes), and its Payment Adjustment applies to that pavement lot in addition to any mat related payment adjustment.

39-4.05B; delete: The 21st sublot becomes the 1st sublot (n=1) in the next lot. When the 21st sequential sublot becomes the 1st sublot, the previous 20 sequential sublots become a lot for which the Engineer determines a quality factor. The Engineer uses this quality factor to pay for the HMA in the lot. If the next lot consists of less than 8 sublots, these sublots must be added to the previous lot for quality factor determination using 21 to 27 sublots.

And replace this with: The 7th sublot becomes the 1st sublot (i = 1) in the next lot. When the 7th sequential sublot becomes the 1st sublot, the previous 6 sequential sublots become a lot for which the Engineer determines a quality factor. The Engineer uses this quality factor to pay for the HMA in the lot. If the next lot consists of less than 4 sublots, these sublots must be added to the previous lot for quality factor determination using 7 to 9 sublots.

39-5 "Measurement and Payment"

39-5.01; delete the text relating to rumble strips.

39-5.02; delete the text relating to rumble strips.

39-5.02; add: The total of payment adjustments shall not result in a total payment of more than 100% of the contract price.

END

APPENDIX F2

Caltrans SECTION 39

HOT MIX ASPHALT

SECTION 39 HOT MIX ASPHALT

(Issued 03-21-08)

Replace Section 39 with:
SECTION 39 HOT MIX ASPHALT

39-1 GENERAL

39-1.01 DESCRIPTION

Section 39 includes specifications for producing and placing hot mix asphalt (HMA) by mixing aggregate and asphalt binder at a mixing plant and spreading and compacting the HMA mixture.
The special provisions specify one or more type of HMA, including:

1. Type A
2. Type B
3. Open graded friction course (OGFC). OGFC includes hot mix asphalt (open graded), rubberized hot mix asphalt (open graded) (RHMA-O) and rubberized hot mix asphalt (open graded high binder) (RHMA-O-HB)
4. Rubberized hot mix asphalt (gap graded) (RHMA-G)

The special provisions specify the HMA construction process, including:

1. Standard
2. Method
3. Quality Control / Quality Assurance (QC / QA)

39-1.02 MATERIALS

39-1.02A GEOSYNTHETIC PAVEMENT INTERLAYER

Geosynthetic pavement interlayer must comply with the specifications for pavement reinforcing fabric in Section 88, "Engineering Fabrics."

39-1.02B TACK COAT

Tack coat must comply with the specifications for asphaltic emulsion in Section 94, "Asphaltic Emulsion," or asphalt binder in Section 92, "Asphalts." Choose the type and grade.

39-1.02C ASPHALT BINDER

Asphalt binder in HMA must comply with Section 92, "Asphalts," or Section 39-1.02D, "Asphalt Rubber Binder." The special provisions specify the grade.
Asphalt binder for geosynthetic pavement interlayer must comply with Section 92, "Asphalts." Choose from Grades PG 64-10, PG 64-16, or PG 70-10.

39-1.02D ASPHALT RUBBER BINDER

General

Use asphalt rubber binder in RHMA-G, RHMA-O, and RHMA-O-HB. Asphalt rubber binder must be a combination of:

1. Asphalt binder
2. Asphalt modifier
3. Crumb rubber modifier (CRM)

The combined asphalt binder and asphalt modifier must be 80.0 ± 2.0 percent by mass of the asphalt rubber binder.

Asphalt Modifier

Asphalt modifier must be a resinous, high flash point, and aromatic hydrocarbon, and comply with:

Asphalt Modifier for Asphalt Rubber Binder

Quality Characteristic	ASTM	Specification
Viscosity, /s (x 10^{-6}) at 100 °C	D 445	X ± 3 [a]
Flash Point, CL.O.C., °C	D 92	207 minimum
Molecular Analysis		
Asphaltenes, percent by mass	D 2007	0.1 maximum
Aromatics, percent by mass	D 2007	55 minimum

Note:
[a] The symbol "X" is the proposed asphalt modifier viscosity. "X" must be between 19 and 36. A change in "X" requires a new asphalt rubber binder design.

Asphalt modifier must be from 2.0 percent to 6.0 percent by mass of the asphalt binder in the asphalt rubber binder.

Crumb Rubber Modifier

CRM consists of a ground or granulated combination of scrap tire CRM and high natural CRM. CRM must be 75.0 ± 2.0 percent scrap tire CRM and 25.0 ± 2.0 percent high natural CRM by total mass of CRM. Scrap tire CRM must be from any combination of automobile tires, truck tires, or tire buffings.
Sample and test scrap tire CRM and high natural CRM separately. CRM must comply with:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality Characteristic	Test Method	Specification
Scrap tire CRM gradation (% passing 2.36-mm sieve)	LP-10	100
High natural CRM gradation (% passing 2.00-mm sieve)	LP-10	100
Wire in CRM (% max.)	LP-10	0.01
Fabric in CRM (% max.)	LP-10	0.05
CRM particle length (mm max.) [a]	--	4.75
CRM specific gravity [a]	CT 208	1.1 – 1.2
Natural rubber content in high natural CRM (%) [a]	ASTM D 297	40.0 – 48.0

Note:
[a] Test at mix design and for Certificate of Compliance.

Only use CRM ground and granulated at ambient temperature. If steel and fiber are cryogenically separated, it must occur before grinding and granulating. Only use cryogenically produced CRM particles that can be ground or granulated and not pass through the grinder or granulator.
CRM must be dry, free-flowing particles that do not stick together. CRM must not cause foaming when combined with the asphalt binder and asphalt modifier. You may add calcium carbonate or talc up to 3 percent by mass of CRM.

Asphalt Rubber Binder Design and Profile

Submit in writing an asphalt rubber binder design and profile. In the design, designate the asphalt, asphalt modifier, and CRM and their proportions. The profile is not a specification and only serves to indicate expected trends in asphalt rubber binder properties during binder production. The profile must include the same component sources for the asphalt rubber binder used.
Design the asphalt rubber binder from testing you perform for each quality characteristic and for the reaction temperatures expected during production. The 24-hour (1,440-minute) interaction period determines the design profile. At a minimum, mix asphalt rubber binder components, take samples, and perform and record the following tests:

Asphalt Rubber Binder Reaction Design Profile

Test	Minutes of Reaction [a]							Limits
	45	60	90	120	240	360	1440	
Cone penetration @ 77 °F, 0.10-mm (ASTM D 217)	X [b]				X		X	25 - 70
Resilience @ 77 °F, percent rebound (ASTM D 5329)	X				X		X	18 min.
Field softening point, °F (ASTM D 36)	X				X		X	125 - 165
Viscosity, centipoises (LP-11)	X	X	X	X	X	X	X	1,500 - 4,000

Notes:
[a] Six hours (360 minutes) after CRM addition, reduce the oven temperature to 135 °C for a period of 16 hours. After the 16-hour (1320 minutes) cool-down after CRM addition, reheat the binder to the reaction temperature expected during production for sampling and testing at 24 hours (1440 minutes).
[b] "X" denotes required testing

Asphalt Rubber Binder

After interacting for a minimum of 45 minutes, asphalt rubber binder must comply with:

Asphalt Rubber Binder

Quality Characteristic	Test for Quality Control or Acceptance	Test Method	Specification	
			Minimum	Maximum
Cone penetration @ 77 °F, 0.10-mm	Acceptance	ASTM D 217	25	70
Resilience @ 77 °F, percent rebound	Acceptance	ASTM D 5329	18	--
Field softening point, °F	Acceptance	ASTM D 36	125	165
Viscosity @ 350 °F, centipoises	Quality Control	LP-11	1,500	4,000

39-1.02E AGGREGATE

Aggregate must be clean and free from deleterious substances. Aggregate:

1. Retained on the 4.75-mm sieve is coarse
2. Passing the 4.75-mm sieve is fine
3. Added and passing the 0.6-mm sieve is supplemental fine, including:

    3.1. Hydrated lime
    3.2. Portland cement
    3.3. Fines from dust collectors

The special provisions specify the aggregate gradation for each HMA type.
The specified aggregate gradation is before the addition of asphalt binder and includes supplemental fines. The Engineer tests for aggregate grading under California Test 202, modified by California Test 105 if there is a difference in specific gravity of 0.2 or more between the coarse and fine parts of different aggregate blends.
Choose a sieve size target value (TV) within each target value limit presented in the aggregate gradation tables.

Aggregate Gradation
(Percentage Passing)
HMA Types A and B

19-mm HMA Types A and B

Sieve Sizes	Target Value Limits	Allowable Tolerance
25-mm	100	—
19-mm	90 – 100	TV ±5
12.5-mm	70 - 90	TV ±6
4.75-mm	45 - 55	TV ±7
2.36-mm	32 - 40	TV ±5
0.6-mm	12 - 21	TV ±4
0.075-mm	2 - 7	TV ±2

12.5-mm HMA Types A and B

Sieve Sizes	Target Value Limits	Allowable Tolerance
19-mm	100	—
12.5-mm	95 - 99	TV ±6
9.5-mm	75 - 95	TV ±6
4.75-mm	55 - 66	TV ±7
2.36-mm	38 - 49	TV ±5
0.6-mm	15 - 27	TV ±4
0.075-mm	2 - 8	TV ±2

9.5-mm HMA Types A and B

Sieve Sizes	Target Value Limits	Allowable Tolerance
12.5-mm	100	—
9.5-mm	95 - 100	TV ±6
4.75-mm	58 - 72	TV ±7
2.36-mm	34 - 48	TV ±6
0.6-mm	18 - 32	TV ±5
0.075-mm	2 - 9	TV ±2

4.75-mm HMA Types A and B

Sieve Sizes	Target Value Limits	Allowable Tolerance
9.5-mm	100	—
4.75-mm	95 - 100	TV ±7
2.36-mm	72 - 77	TV ±7
0.6-mm	37 - 43	TV ±7
0.075-mm	2 - 12	TV ±4

Rubberized Hot Mix Asphalt - Gap Graded (RHMA-G)

19-mm RHMA-G

Sieve Sizes	Target Value Limits	Allowable Tolerance
25-mm	100	—
19-mm	95 - 100	TV ±5
12.5-mm	83 - 87	TV ±6
9.5-mm	65 - 70	TV ±6
4.75-mm	28 - 42	TV ±7
2.36-mm	14 - 22	TV ±5
0.075-mm	0 - 6	TV ±2

12.5-mm RHMA-G

Sieve Sizes	Target Value Limits	Allowable Tolerance
19-mm	100	—
12.5-mm	90 - 100	TV ±6
9.5-mm	83 - 87	TV ±6
4.75-mm	28 - 42	TV ±7
2.36-mm	14 - 22	TV ±5
0.075-mm	0 - 6	TV ±2

Open Graded Friction Course (OGFC)

25-mm OGFC

Sieve Sizes	Target Value Limits	Allowable Tolerance
37.5-mm	100	—
25-mm	99 - 100	TV ±5
19-mm	85 - 96	TV ±5
12.5-mm	55 - 71	TV ±6
4.75-mm	10 - 25	TV ±7
2.36-mm	6 - 16	TV ±5
0.075-mm	1 - 6	TV ±2

12.5-mm OGFC

Sieve Sizes	Target Value Limits	Allowable Tolerance
19-mm	100	—
12.5-mm	95 - 100	TV ±6
9.5-mm	78 - 89	TV ±6
4.75-mm	28 - 37	TV ±7
2.36-mm	7 - 18	TV ±5
0.6-mm	0 - 10	TV ±4
0.075-mm	0 - 3	TV ±2

9.5-mm OGFC

Sieve Sizes	Target Value Limits	Allowable Tolerance
12.5-mm	100	—
9.5-mm	90 - 100	TV ±6
4.75-mm	29 - 36	TV ±7
2.36-mm	7 - 18	TV ±6
0.6-mm	0 - 10	TV ±5
0.075-mm	0 - 3	TV ±2

Before the addition of asphalt binder and lime treatment, aggregate must comply with:

Aggregate Quality

Quality Characteristic	Test Method	HMA Type			
		A	B	RHMA-G	OGFC
Percent of crushed particles Coarse aggregate (% min.) One fractured face Two fractured faces Fine aggregate (% min) (Passing 4.75-mm sieve and retained on 2.36-mm sieve.) One fractured face	CT 205	 90 75 70	 25 -- 20	 -- 90 70	 90 75 90
Los Angeles Rattler (% max.) Loss at 100 Rev. Loss at 500 Rev.	CT 211	 12 45	 -- 50	 12 40	 12 40
Sand equivalent (min.) [a]	CT 217	47	42	47	--
Fine aggregate angularity (% min.) [b]	AASHTO T 304 Method A	45	45	45	--
Flat and elongated particles (% max. by mass @ 5:1)	ASTM D 4791	10	10	10	10
factor (max.)	CT 303	1.7	1.7	1.7	--
factor (max.)	CT 303	1.7	1.7	1.7	--

Notes:
[a] Reported value must be the average of 3 tests from a single sample.
[b] The Engineer waives this specification if HMA contains less than 10 percent of nonmanufactured sand by mass of total aggregate.

39-1.02F RECLAIMED ASPHALT PAVEMENT

You may produce HMA using reclaimed asphalt pavement (RAP). HMA produced using RAP must comply with the specifications for HMA except aggregate quality specifications do not apply to RAP. You may substitute RAP aggregate for a part of the virgin aggregate in HMA in a quantity not exceeding 15 percent of the aggregate blend. Do not use RAP in OGFC and RHMA-G.

Assign the substitution rate of RAP aggregate for virgin aggregate with the job mix formula (JMF) submittal. The JMF must include the percent of RAP used. If you change your assigned RAP aggregate substitution rate by more than 5 percent (within the 15 percent limit), submit a new JMF.

Process RAP from asphalt concrete. You may process and stockpile RAP throughout the project's life. Prevent material contamination and segregation. Store RAP in stockpiles on smooth surfaces free of debris and organic material. Processed RAP stockpiles must consist only of homogeneous RAP.

39-1.03 HOT MIX ASPHALT MIX DESIGN REQUIREMENTS

39-1.03A GENERAL

A mix design consists of performing California Test 367 and laboratory procedures on combinations of aggregate gradations and asphalt binder contents to determine the optimum binder content (OBC) and HMA mixture qualities. If RAP is used, use Laboratory Procedure LP-9. The result of the mix design becomes the proposed JMF.

Use Form CEM-3512 to document aggregate quality and mix design data. Use Form CEM-3511 to present the JMF.
Laboratories testing aggregate qualities and preparing the mix design and JMF must be qualified under the Department's Independent Assurance Program. Take samples under California Test 125.
The Engineer reviews the aggregate qualities, mix design, and JMF and verifies and accepts the JMF.
You may change the JMF during production. Do not use the changed JMF until the Engineer accepts it. Except when adjusting the JMF in compliance with Section 39-1.03E, "Job Mix Formula Verification," perform a new mix design and submit in writing a new JMF submittal for changing any of the following:

1. Target asphalt binder percentage
2. Asphalt binder supplier
3. Asphalt rubber binder supplier
4. Component materials used in asphalt rubber binder or percentage of any component materials
5. Combined aggregate gradation
6. Aggregate sources
7. Substitution rate for RAP aggregate of more than 5 percent
8. Any material in the JMF

For OGFC, submit in writing a complete JMF submittal except asphalt binder content. The Engineer determines the asphalt binder content under California Test 368 within 20 days of your complete JMF submittal and provides you a Form CEM-3513.

39-1.03B HOT MIX ASPHALT FOR JOB MIX FORMULA

Determine the proposed JMF from a mix design that complies with:

Hot Mix Asphalt for Job Mix Formula

Quality Characteristic	Test Method	HMA Type		
		A	B	RHMA-G
Air voids content (%)	CT	4.0	4.0	Special Provisions
Voids in mineral aggregate (% min.)	LP-2			
4.75-mm grading		17.0	17.0	--
9.5-mm grading		15.0	15.0	--
12.5-mm grading		14.0	14.0	18.0 – 23.
19-mm grading		13.0	13.0	18.0 – 23.
Voids filled with asphalt (%)	LP-3			
4.75-mm grading		76.0 – 80.0	76.0 – 80.0	Note d
9.5-mm grading		73.0 – 76.0	73.0 – 76.0	
12.5-mm grading		65.0 – 75.0	65.0 – 75.0	
19-mm grading		65.0 – 75.0	65.0 – 75.0	
Dust proportion	LP-4			
4.75-mm and 9.5-mm gradings		0.9 – 2.0	0.9 – 2.0	Note d
12.5-mm and 19-mm gradings		0.6 – 1.3	0.6 – 1.3	
Stabilometer value (min.) [c]	CT 366			
4.75-mm and 9.5-mm gradings		30	30	--
12.5-mm and 19-mm gradings		37	35	23

Notes:

[a] Calculate the air voids content of each specimen using California Test 309 and Lab Procedure LP-1. Modify California Test 367, Paragraph C5, to use the exact air voids content specified in the selection of OBC.
[b] Voids in mineral aggregate for RHMA-G must be within this range.
[c] Modify California Test 304, Part 2.B.2.c: "After compaction in the compactor, cool to 60 °± 3 °C by allowing the briquettes to cool at room temperature for 0.5-hour, then place the briquettes in the oven at 60 °C for a minimum of 2 hours and not more than 3 hours."
[d] Report this value in the JMF submittal.

For stability, prepare 3 briquettes separately at the proposed JMF and test for compliance. Report the average of 3 tests. Prepare new briquettes and test if the range of stability for the 3 briquettes is more than 12 points. The average air void content may vary from the specified air void content by ±0.5 percent.
You may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If you use the same briquettes and tests using bulk specific gravity fail, you may prepare 3 new briquettes and determine a new bulk specific gravity. If you choose to determine bulk specific gravity with new briquettes and your tests fail, you may not test again using the stability briquettes.

39-1.03C JOB MIX FORMULA SUBMITTAL

Each JMF submittal must consist of:

1. Proposed JMF on Form CEM-3511
2. Mix design documentation on Form CEM-3512 dated within 12 months of submittal
3. JMF verification on Form CEM-3513 dated within 12 months of production start, if applicable
4. Materials Safety Data Sheets (MSDS) for:

4.1. Asphalt binder
4.2. Base asphalt binder used in asphalt rubber binder
4.3. CRM and asphalt modifier used in asphalt rubber binder
4.4. Blended asphalt rubber binder mixture
4.5. Supplemental fine aggregate except fines from dust collectors
4.6. Antistrip additives

If the JMF must be verified or if the Engineer requests, submit samples of the following materials in labeled containers weighing no more than 22.5 kg each (notify the Engineer at least 2 business days before sampling materials):

1. Coarse, fine, and supplemental fine aggregate from stockpiles, cold feed belts, or hot bins. Samples must include at least 55 kg for each coarse aggregate, 35 kg for each fine aggregate, and 4.5 kg for each type of supplemental fines. The Department combines these aggregate samples to comply with the JMF target values submitted on Form CEM-3511.
2. RAP from stockpiles or RAP system. Samples must be at least 30 kg.
3. Asphalt binder from the binder supplier. Samples must be in two 1-liter cylindrical shaped cans with open top and friction lids.
4. Asphalt rubber binder with the components blended in the proportions to be used. Samples must be in four 1-liter cylindrical shaped cans with open top and friction lids.

39-1.03D JOB MIX FORMULA REVIEW

The Engineer reviews each mix design and proposed JMF within 5 business days from the complete JMF submittal. The review consists of reviewing the mix design procedures and comparing the proposed JMF with the specifications.
The Engineer may verify aggregate qualities during this review period.

39-1.03E JOB MIX FORMULA VERIFICATION

If you cannot submit a Department-verified JMF on Form CEM-3513 dated within 12 months before HMA production, the Engineer verifies the JMF.
Based on your testing and production experience, you may submit on Form CEM-3511 an adjusted JMF before the Engineer's verification testing. JMF adjustments may include a change in the:

1. Asphalt binder content target value up to ±0.6 percent from the optimum binder content value submitted on Form CEM-3512 except do not adjust the target value for asphalt rubber binder for RHMA-G below 7.0 percent
2. Aggregate gradation target values within the target value limits specified in the aggregate gradation tables

Test samples from the HMA plant to be used to determine possible JMF adjustments.
For HMA Type A, Type B, and RHMA-G, the Engineer verifies the JMF from samples taken from HMA produced by the plant to be used. The Engineer verifies each proposed

JMF within 20 days of receiving a complete JMF submittal and verification samples. Verification is testing for compliance with the specifications for:

1. Aggregate quality
2. Aggregate gradation (JMF TV ± tolerance)
3. Asphalt binder content (JMF TV ± tolerance)
4. HMA quality specified in the table Hot Mix Asphalt for Job Mix Formula except:

    4.1. Air voids content (design value ± 2.0 percent)
    4.2. Voids filled with asphalt (report only if an adjustment for asphalt binder content target value is less than ± 0.3 percent from optimum binder content)
    4.3. Dust proportion (report only if an adjustment for asphalt binder content target value is less than ± 0.3 percent from optimum binder content)

If you request in writing, the Engineer verifies RHMA-G quality requirements within 3 business days of sampling.
In the Engineer's presence, under California Test 125, and from the same production run, take samples of:

1. Aggregate
2. Asphalt binder
3. RAP
4. HMA

Sample aggregate from cold feed belts or hot bins. Sample RAP from the RAP system. Sample HMA from any of the following locations:

1. The plant
2. A truck
3. A windrow
4. Behind a paver

You may sample from a different project including a non-Department project if you make arrangements for the Engineer to be present during sampling.
For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 split parts to the Engineer and use 1 part for your testing.
The Engineer prepares 3 briquettes from a single split sample. To verify the JMF for stability, the Engineer tests the 3 briquettes and reports the average of 3 tests. The Engineer prepares new briquettes if the range of stability for the 3 briquettes is more than 12 points.
The Engineer may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If the Engineer uses the same briquettes and the tests using bulk specific gravity fail, the Engineer may prepare 3 new briquettes and determine a new bulk specific gravity. If the Engineer chooses to determine bulk specific gravity with new briquettes and the Engineer's tests fail, the Engineer may not test again using the stability briquettes.

If the Engineer verifies the JMF, the Engineer provides you a Form CEM-3513.
If the Engineer's tests on plant-produced samples do not verify the JMF, the Engineer notifies you in writing and you must submit a new JMF submittal or submit an adjusted JMF based on your testing. JMF adjustments may include a change in the:

1. Asphalt binder content target value up to ±0.6 percent from the optimum binder content value submitted on Form CEM-3512 except do not adjust the target value for asphalt rubber binder for RHMA-G below 7.0 percent
2. Aggregate gradation target values within the target value limits specified in the aggregate gradation tables

You may adjust the JMF only once due to a failed verification test. An adjusted JMF requires a new Form CEM-3511 and verification of a plant-produced sample.
The Engineer reverifies the JMF if HMA production has stopped for longer than 30 days and the verified JMF is older than 12 months.
For each HMA type and aggregate size specified, the Engineer verifies at the State's expense up to 2 proposed JMF including a JMF adjusted after verification failure. The Engineer deducts $3,000 from payments for each verification exceeding this limit. This deduction does not apply to verifications initiated by the Engineer or if a JMF expires while HMA production is stopped longer than 30 days.

39-1.03F JOB MIX FORMULA ACCEPTANCE

You may start HMA production if:

1. The Engineer's review of the JMF shows compliance with the specifications.
2. The Department has verified the JMF within 12 months before HMA production.
3. The Engineer accepts the verified JMF.

39-1.04 CONTRACTOR QUALITY CONTROL

39-1.04A GENERAL

Establish, maintain, and change a quality control system to ensure materials and work comply with the specifications. Submit quality control test results to the Engineer within 3 days of a request except when QC / QA is specified.

39-1.04B PREPAVING CONFERENCE

Meet with the Engineer at a prepaving conference at a mutually agreed time and place. Discuss methods of performing the production and paving work.

39-1.04C ASPHALT RUBBER BINDER

Take asphalt rubber binder samples from the feed line connecting the asphalt rubber binder tank to the HMA plant. Sample and test asphalt rubber binder under Laboratory Procedure LP-11.
Test asphalt rubber binder for compliance with the viscosity specifications in Section 39-1.02, "Materials." During asphalt rubber binder production and HMA production using asphalt rubber binder, measure viscosity every hour with not less than 1 reading for each

asphalt rubber binder batch. Log measurements with corresponding time and asphalt rubber binder temperature. Submit the log daily in writing.

Submit a Certificate of Compliance under Section 6-1.07, "Certificates of Compliance." With the Certificate of Compliance, submit test results in writing for CRM and asphalt modifier with each truckload delivered to the HMA plant. A Certificate of Compliance for asphalt modifier must not represent more than 2250 kg. Use an AASHTO-certified laboratory for testing.

Sample and test gradation and wire and fabric content of CRM once per 4500 kg of scrap tire CRM and once per 1500 kg of high natural CRM. Sample and test scrap tire CRM and high natural CRM separately.

Submit certified weight slips in writing for the CRM and asphalt modifier furnished.

39-1.04D AGGREGATE

Determine the aggregate moisture content and RAP moisture content in continuous mixing plants at least twice a day during production and adjust the plant controller.

Determine the RAP moisture content in batch mixing plants at least twice a day during production and adjust the plant controller.

39-1.04E RECLAIMED ASPHALT PAVEMENT

Perform RAP quality control testing each day.

Sample RAP once daily and determine the RAP aggregate gradation under Laboratory Procedure LP-9 and submit the results to the Engineer in writing with the combined aggregate gradation.

39-1.04F CORES

For Standard and QC / QA projects, take 100-mm or 150-mm diameter cores at least once every 5 business days. Take 1 core for every 225 tonnes of HMA from random locations the Engineer designates. Take cores in the Engineer's presence and backfill and compact holes with material authorized by the Engineer. Before submitting a core to the Engineer, mark it with the core's location and place it in a protective container.

If a core is damaged, replace it with a core taken within 0.3 m longitudinally from the original core. Relocate any core located within 0.3 m of a rumble strip to 0.3 m transversely away from the rumble strip.

39-1.04G BRIQUETTES

Prepare 3 briquettes separately for each stability determination. Report the average of 3 tests. Prepare new briquettes and test if the range of stability for the 3 briquettes is more than 12 points.

You may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If you use the same briquettes and tests using bulk specific gravity fail, you may prepare 3 new briquettes and determine a new bulk specific gravity. If you choose to determine bulk specific gravity with new briquettes and your tests fail, you may not test again using the stability briquettes.

39-1.05 ENGINEER'S ACCEPTANCE

The Engineer's acceptance of HMA is specified in the sections for each HMA construction process.
The Engineer samples materials for testing under California Test 125 and the applicable test method. Sampling must be statistically-based and random.
The Engineer takes HMA and aggregate samples during production and splits each sample into 2 parts. The Engineer tests 1 part to verify quality control test results and reserves and stores the remaining part. If you request, the Engineer splits samples and provides you with a part.

The Engineer accepts HMA based on:

1. Accepted JMF
2. Accepted QCP for Standard and QC / QA
3. Compliance with the HMA Acceptance tables
4. Acceptance of a lot for QC / QA
5. Visual inspection

The Engineer prepares 3 briquettes separately for each stability determination. The Engineer reports the average of 3 tests. The Engineer prepares new briquettes and test if the range of stability for the 3 briquettes is more than 12 points.
The Engineer may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If the Engineer uses the same briquettes and the tests using bulk specific gravity fail, the Engineer may prepare 3 new briquettes and determine a new bulk specific gravity. If the Engineer chooses to determine bulk specific gravity with new briquettes and the Engineer tests fail, the Engineer may not test again using the stability briquettes.

39-1.06 DISPUTE RESOLUTION

You and the Engineer must work together to avoid potential conflicts and to resolve disputes regarding test result discrepancies. Notify the Engineer in writing within 5 days of receiving a test result if you dispute the test result.
If you or the Engineer dispute each other's test results, submit written quality control test results and copies of paperwork including worksheets used to determine the disputed test results to the Engineer. An Independent Third Party (ITP) performs referee testing. Before the ITP participates in a dispute resolution, the ITP must be accredited under the Department's Independent Assurance Program. The ITP must be independent of the project. By mutual agreement, the ITP is chosen from:

1. A Department laboratory
2. A Department laboratory in a district or region not in the district or region the project is located
3. The Transportation Laboratory
4. A laboratory not currently employed by you or your HMA producer

If split quality control or acceptance samples are not available, the ITP uses any available material representing the disputed HMA for evaluation.

39-1.07 PRODUCTION START-UP EVALUATION

The Engineer evaluates HMA production and placement at production start-up.
Within the first 680 tonnes produced on the first day of HMA production, in the Engineer's presence and from the same production run, take samples of:

1. Aggregate
2. Asphalt binder
3. RAP
4. HMA

Sample aggregate from cold feed belts or hot bins. Take RAP samples from the RAP system. Sample HMA under California Test 125. For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 split parts to the Engineer and keep 1 part.
For Standard and QC / QA projects, you and the Engineer must test the split samples for compliance with specifications. You and the Engineer must report test results in writing within 3 business days of sampling.
For Standard and QC / QA projects, take 100-mm or 150-mm diameter cores within the first 680 tonnes on the first day of HMA production. For each core, the Engineer reports the bulk specific gravity determined under California Test 308, Method A in addition to the percent of maximum theoretical density. You may test for in-place density at the core locations and include them in your production tests for percent of maximum theoretical density.

39-1.08 PRODUCTION

39-1.08A GENERAL

Produce HMA in a batch mixing plant or a continuous mixing plant. Proportion aggregate by hot or cold feed control.
HMA plants must be Department-qualified. Before production, the HMA plant must have a current qualification under the Department's Materials Plant Quality Program.
During production, you may adjust:

1. Hot or cold feed proportion controls for virgin aggregate and RAP
2. The set point for asphalt binder content

39-1.08B MIXING

Mix HMA ingredients into a homogeneous mixture of coated aggregates.
Asphalt binder must be between 135 °C and 190 °C when mixed with aggregate.
Asphalt rubber binder must be between 177 °C and 218 °C when mixed with aggregate.
Aggregate must not be more than 163 °C when mixed with asphalt binder. Aggregate temperature specifications do not apply when you use RAP.
HMA with or without RAP must not be more than 163 °C.

39-1.08C ASPHALT RUBBER BINDER

Deliver scrap tire CRM and high natural CRM in separate bags.
Either proportion and mix asphalt binder, asphalt modifier, and CRM simultaneously or premix the asphalt binder and asphalt modifier before adding CRM. If you premix asphalt binder and asphalt modifier, the asphalt binder must be between 177 °C and 218 °C when you add asphalt modifier. Mix them for at least 20 minutes. When you add CRM, the asphalt binder and asphalt modifier must be between 177 °C and 218 °C.
Do not use asphalt rubber binder during the first 45 minutes of the reaction period. During this period, the asphalt rubber binder mixture must be between 177 °C and the lower of 218 °C or 6 °C below the asphalt binder's flash point indicated in the MSDS.
If any asphalt rubber binder is not used within 4 hours after the reaction period, discontinue heating. If the asphalt rubber binder drops below 177 °C, reheat before use. If you add more scrap tire CRM to the reheated asphalt rubber binder, the binder must undergo a 45-minute reaction period. The added scrap tire CRM must not exceed 10 percent of the total asphalt rubber binder mass. Reheated and reacted asphalt rubber binder must comply with the viscosity specifications for asphalt rubber binder in Section 39-1.02, "Materials." Do not reheat asphalt rubber binder more than twice.

39-1.09 SUBGRADE, TACK COAT, AND GEOSYNTHETIC PAVEMENT INTERLAYER

39-1.09A GENERAL

Prepare subgrade or apply tack coat to surfaces receiving HMA. If specified, place geosynthetic pavement interlayer over a coat of asphalt binder.

39-1.09B SUBGRADE

Subgrade to receive HMA must comply with the compaction and elevation tolerance specifications in the sections for the material involved. Subgrade must be free of loose and extraneous material. If HMA is paved on existing base or pavement, remove loose paving particles, dirt, and other extraneous material by any means including flushing and sweeping.

39-1.09C TACK COAT

Apply tack coat:

1. To existing pavement including planed surfaces
2. Between HMA layers
3. To vertical surfaces of:

    3.1. Curbs
    3.2. Gutters
    3.3. Construction joints

Before placing HMA, apply tack coat in 1 application at the minimum residual rate specified for the condition of the underlying surface:

Tack Coat Application Rates for HMA Type A, Type B, and RHMA-G

HMA Overlay over:	Minimum Residual Rates (liters per square meter)		
	CSS1/CSS1h, SS1/SS1h and QS1h/CQS1h Asphaltic Emulsion	CRS1/CRS2, RS1/RS2 and QS1/CQS1 Asphaltic Emulsion	Asphalt Binder and PMRS2/PMCRS2 and PMRS2h/PMCRS2h Asphaltic Emulsion
New HMA (between layers)	0.09	0.14	0.09
Existing AC and PCC pavement	0.14	0.18	0.14
Planed pavement	0.23	0.27	0.18

Tack Coat Application Rates for OGFC

OGFC over:	Minimum Residual Rates (liters per square meter)		
	CSS1/CSS1h, SS1/SS1h and QS1h/CQS1h Asphaltic Emulsion	CRS1/CRS2, RS1/RS2 and QS1/CQS1 Asphaltic Emulsion	Asphalt Binder and PMRS2/PMCRS2 and PMRS2h/PMCRS2h Asphaltic Emulsion
New HMA	0.14	0.18	0.14
Existing AC and PCC pavement	0.23	0.27	0.18
Planed pavement	0.27	0.32	0.23

Apply to vertical surfaces with a residual tack coat rate that will thoroughly coat the vertical face without running off.
If you request in writing and the Engineer authorizes, you may change tack coat rates.
Immediately in advance of placing HMA, apply additional tack coat to damaged areas or where loose or extraneous material is removed.
Close areas receiving tack coat to traffic. Do not track tack coat onto pavement surfaces beyond the job site.
Asphalt binder tack coat must be between 140 °C and 175 °C when applied.

39-1.09D GEOSYNTHETIC PAVEMENT INTERLAYER

Before placing the geosynthetic pavement interlayer and asphalt binder:

1. Repair cracks 6 mm and wider, spalls, and holes in the pavement. The State pays for this repair work under Section 4-1.03D, "Extra Work."
2. Clean the pavement of loose and extraneous material.

Immediately before placing the interlayer, apply 1.13 liter ± 0.14 liter of asphalt binder per square meter of interlayer or until the fabric is saturated. Apply asphalt binder the width of the geosynthetic pavement interlayer plus 75 mm on each side. At interlayer overlaps, apply asphalt binder on the lower interlayer the same overlap distance as the upper interlayer.
Align and place the interlayer with no overlapping wrinkles, except a wrinkle that overlaps may remain if it is less than 12.5 mm thick. If the overlapping wrinkle is more than 12.5 mm thick, cut the wrinkle out and overlap the interlayer no more than 50 mm.
The minimum HMA thickness over the interlayer must be 35 mm thick including conform tapers. Do not place the interlayer on a wet or frozen surface.

Overlap the interlayer borders between 50 mm and 100 mm. In the direction of paving, overlap the following roll with the preceding roll at any break.
You may use rolling equipment to correct distortions or wrinkles in the interlayer.
If asphalt binder tracked onto the interlayer or brought to the surface by construction equipment causes interlayer displacement, cover it with a small quantity of HMA.
Before placing HMA on the interlayer, do not expose the interlayer to:

1. Traffic except for crossings under traffic control and only after you place a small HMA quantity
2. Sharp turns from construction equipment
3. Damaging elements

Pave HMA on the interlayer during the same work shift.

39-1.10 SPREADING AND COMPACTING EQUIPMENT

Paving equipment for spreading must be:

1. Self-propelled
2. Mechanical
3. Equipped with a screed or strike-off assembly that can distribute HMA the full width of a traffic lane
4. Equipped with a full-width compacting device
5. Equipped with automatic screed controls and sensing devices that control the thickness, longitudinal grade, and transverse screed slope

Install and maintain grade and slope references.
The screed must produce a uniform HMA surface texture without tearing, shoving, or gouging.
The paver must not leave marks such as ridges and indentations unless you can eliminate them by rolling.
Rollers must be equipped with a system that prevents HMA from sticking to the wheels. You may use a parting agent that does not damage the HMA or impede the bonding of layers.
In areas inaccessible to spreading and compacting equipment:

1. Spread the HMA by any means to obtain the specified lines, grades and cross sections.
2. Use a pneumatic tamper, plate compactor, or equivalent to achieve thorough compaction.

39-1.11 TRANSPORTING, SPREADING, AND COMPACTING

Do not pave HMA on a wet pavement or frozen surface.
You may deposit HMA in a windrow and load it in the paver if:

1. Paver is equipped with a hopper that automatically feeds the screed

2. Loading equipment can pick up the windrowed material and deposit it in the paver hopper without damaging base material
3. Activities for deposit, pick-up, loading, and paving are continuous
4. HMA temperature in the windrow does not fall below 127 °C

You may pave HMA in 1 or more layers on areas less than 1.5 m wide and outside the traveled way including shoulders. You may use mechanical equipment other than a paver for these areas. The equipment must produce a uniform smoothness and texture.
HMA handled, spread, or windrowed must not stain the finished surface of any improvement including pavement.
Do not use petroleum products such as kerosene or diesel fuel to release HMA from trucks, spreaders, or compactors.
HMA must be free of:

1. Segregation
2. Coarse or fine aggregate pockets
3. Hardened lumps

Longitudinal joints in the top layer must match specified lane edges. Alternate longitudinal joint offsets in lower layers at least 0.15 m from each side of the specified lane edges. You may request in writing other longitudinal joint placement patterns.
Until the adjoining through lane's top layer has been paved, do not pave the top layer of:

1. Shoulders
2. Tapers
3. Transitions
4. Road connections
5. Private drives
6. Curve widenings
7. Chain control lanes
8. Turnouts
9. Left turn pockets

If the number of lanes change, pave each through lane's top layer before paving a changing lane's top layer. Simultaneous to paving a through lane's top layer, you may pave an adjoining area's top layer including shoulders. Do not operate spreading equipment on any area's top layer until completing final compaction.
If HMA (leveling) is specified, fill and level irregularities and ruts with HMA before spreading HMA over base, existing surfaces, or bridge decks. You may use mechanical equipment other than a paver for these areas. The equipment must produce a uniform smoothness and texture. HMA used to change an existing surface's cross slope or profile is not HMA (leveling).
If placing HMA against the edge of existing pavement, sawcut or grind the pavement straight and vertical along the joint and remove extraneous material without damaging the surface remaining in place. If placing HMA against the edge of a longitudinal or transverse construction joint and the joint is damaged or not placed to a neat line, sawcut

or grind the pavement straight and vertical along the joint and remove extraneous material without damaging the surface remaining in place. Repair or remove and replace damaged pavement at your expense.
Rolling must leave the completed surface compacted and smooth without tearing, cracking, or shoving. Complete finish rolling activities before the pavement surface temperature is:

1. Below 65 °C for HMA with unmodified binder
2. Below 60 °C for HMA with modified binder
3. Below 93 °C for RHMA-G

If a vibratory roller is used as a finish roller, turn the vibrator off.
Do not use a pneumatic tired roller to compact RHMA-G.
For Standard and QC/QA, if a 19-mm aggregate grading is specified, you may use a 12.5-mm aggregate grading if the total layer thickness is between 38 mm and 60 mm thick.
Spread and compact HMA under Section 39-3.03, "Spreading and Compacting Equipment," and Section 39-3.04, "Transporting, Spreading, and Compacting," if either:

1. Total paved thickness is less than 45 mm.
2. Total paved thickness is less than 60 mm and a 19-mm aggregate grading is specified and used.
3. You spread and compact at:

    3.1. Asphalt concrete surfacing replacement areas
    3.2. Leveling courses
    3.3. Detours not included in the final roadway prism
    3.4. Areas the Engineer determines conventional compaction and compaction measurement methods are impeded

Do not allow traffic on new HMA pavement until its mid-depth temperature is below 71 °C.
If you request in writing and the Engineer authorizes, you may cool HMA Type A and Type B with water when rolling activities are complete. Apply water under Section 17, "Watering."
Spread sand at a rate between 0.5 kg and 1 kg per square meter on new RHMA-G, RHMA-O, and RHMA-O-HB pavement when finish rolling is complete. Sand must be free of clay or organic matter. Sand must comply with Section 90-3.03, "Fine Aggregate Grading." Keep traffic off the pavement until spreading sand is complete.

39-1.12 SMOOTHNESS

39-1.12A GENERAL

Determine HMA smoothness with a profilograph and a straightedge.
Smoothness specifications do not apply to OGFC placed on existing pavement not constructed under the same project.
If portland cement concrete is placed on HMA:

1. Cold plane the HMA finished surface to within specified tolerances if it is higher than the grade specified by the Engineer.
2. Remove and replace HMA if the finished surface is lower than 15 mm below the grade specified by the Engineer.

39-1.12B STRAIGHTEDGE

The HMA pavement top layer must not vary from the lower edge of a 3.66-m long straightedge:

1. More than 3 mm when the straight edge is laid parallel with the centerline
2. More than 6 mm when the straightedge is laid perpendicular to the centerline and extends from edge to edge of a traffic lane
3. More than 6 mm when the straightedge is laid within 7.3 m of a pavement conform

39-1.12C PROFILOGRAPH

Under California Test 526, determine the zero (null) blanking band Profile Index (PI_0) and must-grinds on the top layer of HMA Type A, Type B, and RHMA-G pavement.
Take 2 profiles within each traffic lane, 3 feet from and parallel with the edge of each lane.
A must-grind is a deviation of 1 m or more in a length of 7.5 m. You must correct must-grinds.
For OGFC, only determine must-grinds when placed over HMA constructed under the same project. The top layer of the underlying HMA must comply with the smoothness specifications before placing OGFC.
Profile pavement in the Engineer's presence. Choose the time of profiling.
On tangents and horizontal curves with a centerline radius of curvature 600 m or more, the PI_0 must be at most 75 mm per 160-m section.
On horizontal curves with a centerline radius of curvature between 300 m and 600 m including pavement within the superelevation transitions, the PI_0 must be at most 150 mm per 160-m section.
Before the Engineer accepts HMA pavement for smoothness, submit written final profilograms.
Submit 1 electronic copy of profile information in Microsoft Excel and 1 electronic copy of longitudinal pavement profiles in ".erd" format or other ProVAL compatible format to the Engineer and to:

Smoothness@dot.ca.gov

The following HMA pavement areas do not require a $PI_{0.}$ You must measure these areas with a 3.6-m straightedge and determine must-grinds with a profilograph:

1. New HMA with a total thickness less than or equal to 75 mm
2. HMA sections of city or county streets and roads, turn lanes and collector lanes that are less than 460 m in length

The following HMA pavement areas do not require a $PI_{0.}$ You must measure these areas with a 3.6-m straightedge:

1. Horizontal curves with a centerline radius of curvature less than 300 m including pavement within the superelevation transitions of those curves
2. Within 3.66 m of a transverse joint separating the pavement from:

    2.1. Existing pavement not constructed under the same project
    2.2. A bridge deck or approach slab

3. Exit ramp termini, truck weigh stations, and weigh-in-motion areas
4. If steep grades and superelevation rates greater than 6 percent are present on:

    4.1. Ramps
    4.2. Connectors

5. Turn lanes and areas around manholes or drainage transitions
6. Acceleration and deceleration lanes for at-grade intersections
7. Shoulders and miscellaneous areas
8. HMA pavement within 1 m from and parallel to the construction joints formed between curbs, gutters, or existing pavement

39-1.12D SMOOTHNESS CORRECTION

If the top layer of HMA Type A, Type B, or RHMA-G pavement does not comply with the smoothness specifications, grind the pavement to within tolerances, remove and replace it, or place an overlay of HMA. The Engineer must authorize your choice of correction before the work begins.

Remove and replace the areas of OGFC not in compliance with the must-grind and straightedge specifications, except you may grind OGFC for correcting smoothness:

1. At a transverse joint separating the pavement from pavement not constructed under the same project
2. Within 3.66 m of a transverse joint separating the pavement from a bridge deck or approach slab

Corrected HMA pavement areas must be uniform rectangles with edges:

1. Parallel to the nearest HMA pavement edge or lane line
2. Perpendicular to the pavement centerline

After correcting for smoothness, measure the corrected HMA pavement surface with a profilograph and a 3.66-m straightedge until the pavement is within specified tolerances. If a must-grind area or straightedged pavement cannot be corrected to within specified tolerances, remove and replace the pavement.

On ground areas not overlaid with OGFC, apply fog seal coat under Section 37-1, "Seal Coats."

39-1.13 MISCELLANEOUS AREAS AND DIKES

Miscellaneous areas are outside the traveled way and include:

1. Median areas not including inside shoulders
2. Island areas
3. Sidewalks
4. Gutters
5. Gutter flares
6. Ditches
7. Overside drains
8. Aprons at the ends of drainage structures

Spread miscellaneous areas in 1 layer and compact to the specified lines and grades.
For miscellaneous areas and dikes:

1. Do not submit a JMF.
2. Choose the 9.5-mm or 12.5-mm HMA Type A and Type B aggregate gradations.
3. Minimum asphalt binder content must be 6.8 percent for 9.5-mm aggregate and 6.0 percent for 12.5-mm aggregate. If you request in writing and the Engineer authorizes, you may reduce the minimum asphalt binder content.
4. Choose asphalt binder Grade PG 70-10 or the same grade specified for HMA.

39-1.14 SHOULDER RUMBLE STRIP

Construct shoulder rumble strips by rolling or grinding indentations in the top layer of new HMA surfacing.
Select the method and equipment for constructing ground-in indentations.
Do not construct shoulder rumble strips on structures or approach slabs.
Construct rumble strips within 50 mm of the specified alignment. Roller or grinding equipment must be equipped with a sighting device enabling the operator to maintain the rumble strip alignment.
Rolled-in indentations must not vary from the specified dimensions by more than 10 percent.
Ground-in indentations must comply with the specified dimensions within 1.5 mm in depth or 10 percent in length and width.
The Engineer orders grinding or removal and replacement of noncompliant rumble strips to bring them within specified tolerances. Ground surface areas must be neat and uniform in appearance.
The grinding equipment must be equipped with a vacuum attachment to remove residue.
Dispose of removed material under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way."
On ground areas, apply fog seal coat under Section 37-1, "Seal Coats."

39-2 STANDARD

39-2.01 DESCRIPTION

If HMA is specified as Standard, construct it under Section 39-1, "General," this Section 39-2, "Standard," and Section 39-5, "Measurement and Payment."

39-2.02 CONTRACTOR QUALITY CONTROL

39-2.02A QUALITY CONTROL PLAN

Establish, implement, and maintain a Quality Control Plan (QCP) for HMA. The QCP must describe the organization and procedures you will use to:

1. Control the quality characteristics
2. Determine when corrective actions are needed (action limits)
3. Implement corrective actions

When you submit the proposed JMF, submit the written QCP. You and the Engineer must discuss the QCP during the prepaving conference.
The QCP must address the elements affecting HMA quality including:

1. Aggregate
2. Asphalt binder
3. Additives
4. Production
5. Paving

39-2.02B QUALITY CONTROL TESTING

Perform sampling and testing at the specified frequency for the following quality characteristics:

Minimum Quality Control – Standard

Quality Characteristic	Test Method	Minimum Sampling and Testing Frequency	HMA Type			
			A	B	RHMA-G	OGFC
Aggregate	CT 202	1 per 680 tonnes and any remaining part	JMF ± Tolerance [b]	JMF ± Tolerance [b]	JMF ± Tolerance [b]	JMF ± Tolerance [b]
Sand equivalent (min.) [c]	CT 217		47	42	47	--
Asphalt binder content (%)	CT 379 or 382		JMF ± 0.45	JMF ± 0.45	JMF ± 0.50	JMF +0.50 -0.70
HMA moisture content (%, max.)	CT 226 or CT 370	1 per 2250 tonnes but not less than 1 per paving day	1.0	1.0	1.0	1.0
Percent of maximum theoretical density (%) [d, e]	Quality control plan	2 per business day (min.)	91 - 97	91 - 97	91 - 97	--
Stabilometer value (min.) [c, f] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings	CT 366	One per 3600 tonnes or 2 per 5 business days, which-ever is more	 30 37	 30 35	 -- 23	 -- --
Air voids content (%) [c, g]	CT 367		4 ± 2	4 ± 2	Specification ± 2	--
Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants [h]	CT 226 or CT 370	2 per day during production	--	--	--	--
Percent of crushed particles coarse aggregate (%, min.) One fractured face Two fractured faces Fine aggregate (%, min) (Passing 4.75-mm sieve and retained on 2.36-mm sieve.) One fractured face	CT 205	As necessary and designat-ed in the QCP. At least once per project	 90 75 70	 25 -- 20	 -- 90 70	 90 75 90

Los Angeles Rattler (%, max.) Loss at 100 rev. Loss at 500 rev.	CT 211		 12 45	 -- 50	 12 40	 12 40
Fine aggregate angularity (%, min.)	AASHTO T 304, Method A		Report only	Report only	Report only	--
Flat and elongated particles (%, max. by mass @ 5:1)	ASTM D 4791		Report only	Report only	Report only	Report only
Voids filled with asphalt (%) [i] 4.75-mm grading 9.5-mm grading 12.5-mm grading 19-mm grading	LP-3		 76.0 – 80.0 73.0 – 76.0 65.0 – 75.0 65.0 – 75.0	 76.0 – 80.0 73.0 – 76.0 65.0 – 75.0 65.0 – 75.0	 Report only	--
Voids in mineral aggregate (% min.) [i] 4.75-mm grading 9.5-mm grading 12.5-mm grading 19-mm grading	LP-2		 17.0 15.0 14.0 13.0	 17.0 15.0 14.0 13.0	 -- -- 18.0 – 23.0 [j] 18.0 – 23.0 [j]	--
Dust proportion [i] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings	LP-4		 0.9 – 2.0 0.6 – 1.3	 0.9 – 2.0 0.6 – 1.3	 Report only	--
Smoothness	Section 39-1.12	--	3.66-m straightedge, must-grind, and	3.66-m straightedge, must-grind, and	3.66-m straightedge, must-grind, and	3.66-m straightedge and must-grind
Asphalt rubber binder viscosity @ 177 °C, centipoises	Section 39-1.02D	--	--	--	1,500 – 4,000	1,500 – 4,000
Crumb rubber modifier	Section 39-1.02D	--	--	--	Section 39-1.02D	Section 39-1.02D

Notes:
[a] Determine combined aggregate gradation containing RAP under Laboratory Procedure LP-9.
[b] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[c] Report the average of 3 tests from a single split sample.
[d] Required for HMA Type A, Type B, and RHMA-G if the total paved thickness is at least 45 mm.
[e] Determine maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 60 °C ± 3 °C by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 69 °C for a minimum of 2 hours and not more than 3 hours."
[g] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[h] For adjusting the plant controller at the HMA plant.
[i] Report only if the adjustment for asphalt binder content target value is less than ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

For any single quality characteristic except smoothness, if 2 consecutive quality control test results do not comply with the action limits or specifications:

1. Stop production.
2. Notify the Engineer in writing.
3. Take corrective action.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

39-2.03 ENGINEER'S ACCEPTANCE

39-2.03A TESTING

The Engineer samples for acceptance testing and tests for:

HMA Acceptance - Standard

<table>
<tr><th colspan="4" rowspan="2">Quality Characteristic</th><th rowspan="2">Test Method</th><th colspan="4">HMA Type</th></tr>
<tr><th>A</th><th>B</th><th>RHMA-G</th><th>OGFC</th></tr>
<tr><td colspan="4">Aggregate gradation [a]</td><td rowspan="7">CT 202</td><td rowspan="7">JMF ± Tolerance [c]</td><td rowspan="7">JMF ± Tolerance [c]</td><td rowspan="7">JMF ± Tolerance [c]</td><td rowspan="7">JMF ± Tolerance [c]</td></tr>
<tr><td>Sieve</td><td>19 mm</td><td>12.5 mm</td><td>9.5 mm</td></tr>
<tr><td>12.5-mm</td><td>X [b]</td><td></td><td></td></tr>
<tr><td>9.5-mm</td><td></td><td>X</td><td></td></tr>
<tr><td>4.75-mm</td><td></td><td></td><td>X</td></tr>
<tr><td>2.36-mm</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>0.075-mm</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="4">Sand equivalent (min.) [d]</td><td>CT 217</td><td>47</td><td>42</td><td>47</td><td>--</td></tr>
<tr><td colspan="4">Asphalt binder content (%)</td><td>CT 379 or 382</td><td>JMF ± 0.45</td><td>JMF ± 0.45</td><td>JMF ± 0.5</td><td>JMF
+0.50
-0.70</td></tr>
<tr><td colspan="4">HMA moisture content (%, max.)</td><td>CT 226 or CT 370</td><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td></tr>
<tr><td colspan="4">Percent of maximum theoretical density (%) [e, f]</td><td>CT 375</td><td>91 – 97</td><td>91 – 97</td><td>91 – 97</td><td>--</td></tr>
<tr><td colspan="4">Stabilometer value (min.) [d, g]
4.75-mm and 9.5-mm gradings
12.5-mm and 19-mm gradings</td><td>CT 366</td><td>
30
37</td><td>
30
35</td><td>
--
23</td><td>
--
--</td></tr>
<tr><td colspan="4">Air voids content (%) [d, h]</td><td>CT 367</td><td>4 ± 2</td><td>4 ± 2</td><td>Specification ± 2</td><td>--</td></tr>
<tr><td colspan="4">Percent of crushed particles
Coarse aggregate (%, min.)
One fractured face
Two fractured faces
Fine aggregate (%, min)
(Passing 4.75-mm sieve and retained on 2.36-mm sieve.)
One fractured face</td><td>CT 205</td><td>

90
75

70</td><td>

25
--

20</td><td>

--
90

70</td><td>

90
75

90</td></tr>
<tr><td colspan="4">Los Angeles Rattler (%, max.)
Loss at 100 rev.
Loss at 500 rev.</td><td>CT 211</td><td>12
45</td><td>--
50</td><td>12
40</td><td>12
40</td></tr>
<tr><td colspan="4">Fine aggregate angularity (%, min.)</td><td>AASHTO T 304, Method A</td><td>Report only</td><td>Report only</td><td>Report only</td><td>--</td></tr>
<tr><td colspan="4">Flat and elongated particles (%, max. by mass @ 5:1)</td><td>ASTM D 4791</td><td>Report only</td><td>Report only</td><td>Report only</td><td>Report only</td></tr>
<tr><td colspan="4">Voids filled with asphalt (%) [i]
4.75-mm grading
9.5-mm grading
12.5-mm grading
19-mm grading</td><td>LP-3</td><td>
76.0 – 80.0
73.0 – 76.0
65.0 – 75.0
65.0 – 75.0</td><td>
76.0 – 80.0
73.0 – 76.0
65.0 – 75.0
65.0 – 75.0</td><td>
Report only</td><td>--</td></tr>
<tr><td colspan="4">Voids in mineral aggregate (% min.) [i]
4.75-mm grading
9.5-mm grading
12.5-mm grading</td><td>LP-2</td><td>
17.0
15.0
14.0</td><td>
17.0
15.0
14.0</td><td>
--
--
18.0 – 23.0 [j]</td><td>--</td></tr>
</table>

19-mm grading		13.0	13.0	18.0 – 23.0 [j]	
Dust proportion [i] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings	LP-4	 0.9 – 2.0 0.6 – 1.3	 0.9 – 2.0 0.6 – 1.3	Report only	--
Smoothness	Section 39-1.12	3.66-m straightedge, must-grind, and	3.66-m straightedge, must-grind, and	3.66-m straightedge, must-grind, and	3.66-m straightedge and must-grind
Asphalt binder	Various	Section 92	Section 92	Section 92	Section 92
Asphalt rubber binder	Various	--	--	Section 92-1.02(C) and Section 39-1.02D	Section 92-1.02(C) and Section 39-1.02D
Asphalt modifier	Various	--	--	Section 39-1.02D	Section 39-1.02D
Crumb rubber modifier	Various	--	--	Section 39-1.02D	Section 39-1.02D

[a] The Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.
[b] "X" denotes the sieves the Engineer considers for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[d] The Engineer reports the average of 3 tests from a single split sample.
[e] The Engineer determines percent of maximum theoretical density if the total paved thickness is at least 45 mm under California Test 375 except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[f] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[g] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 60 °C ±3 °C by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 60 °C for a minimum of 2 hours and not more than 3 hours."
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for asphalt binder content target value is less than ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

No single test result may represent more than the smaller of 680 tonnes or 1 day's production.
For any single quality characteristic except smoothness, if 2 consecutive acceptance test results do not comply with the specifications:

1. Stop production.
2. Take corrective action.
3. In the Engineer's presence, take samples and split each sample into 4 parts. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Engineer tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

The Engineer tests the core you take from each 225 tonnes of HMA production. The Engineer determines the percent of maximum theoretical density for each core by determining the core's density and dividing by the maximum theoretical density.
If the total paved thickness is at least 45 mm and any layer is less than 45 mm, the Engineer determines the percent of maximum theoretical density from cores taken from the final layer measured the full depth of the total paved HMA thickness.
For percent of maximum theoretical density, the Engineer determines a deduction for each test result outside the specifications in compliance with:

Reduced Payment Factors for Percent of Maximum Theoretical Density

HMA Type A and B and RHMA-G Percent of Maximum Theoretical Density	Reduced Payment Factor	HMA Type A and B and RHMA-G Percent of Maximum Theoretical Density	Reduced Payment Factor
91.0	0.0000	97.0	0.0000
90.9	0.0125	97.1	0.0125
90.8	0.0250	97.2	0.0250
90.7	0.0375	97.3	0.0375
90.6	0.0500	97.4	0.0500
90.5	0.0625	97.5	0.0625
90.4	0.0750	97.6	0.0750
90.3	0.0875	97.7	0.0875
90.2	0.1000	97.8	0.1000
90.1	0.1125	97.9	0.1125
90.0	0.1250	98.0	0.1250
89.9	0.1375	98.1	0.1375
89.8	0.1500	98.2	0.1500
89.7	0.1625	98.3	0.1625
89.6	0.1750	98.4	0.1750
89.5	0.1875	98.5	0.1875
89.4	0.2000	98.6	0.2000
89.3	0.2125	98.7	0.2125
89.2	0.2250	98.8	0.2250
89.1	0.2375	98.9	0.2375
89.0	0.2500	99.0	0.2500
< 89.0	Remove and Replace	> 99.0	Remove and Replace

39-2.04 TRANSPORTING, SPREADING, AND COMPACTING

Determine the number of rollers needed to obtain the specified density and surface finish.

39-3 METHOD

39-3.01 DESCRIPTION

If HMA is specified as Method, construct it under Section 39-1, "General," this Section 39-3, "Method," and Section 39-5, "Measurement and Payment."

39-3.02 ENGINEER'S ACCEPTANCE

39-3.02A TESTING

The Engineer samples for acceptance testing and tests for:

HMA Acceptance - Method

Quality Characteristic	Test Method	HMA Type			
		A	B	RHMA-G	OGFC
Aggregate gradation [a]	CT 202	JMF ± Tolerance [b]	JMF ± Tolerance [b]	JMF ± Tolerance [b]	JMF ± Tolerance [b]
Sand equivalent (min.) [c]	CT 217	47	42	47	--
Asphalt binder content (%)	CT 379 or 382	JMF ± 0.45	JMF ± 0.45	JMF ± 0.5	JMF +0.50 -0.70
HMA moisture content (%, max.)	CT 226 or CT 370	1.0	1.0	1.0	1.0
Stabilometer value (min.) [c, d,]	CT 366				
4.75-mm and 9.5-mm gradings		30	30	--	--
12.5-mm and 19-mm gradings		37	35	23	--
Percent of crushed particles	CT 205				
Coarse aggregate (% min.)					
One fractured face		90	25	--	90
Two fractured faces		75	--	90	75
Fine aggregate (% min) (Passing 4.75-mm sieve and retained on 2.36-mm sieve.)					
One fractured face		70	20	70	90
Los Angeles Rattler (% max.)	CT 211				
Loss at 100 rev.		12	--	12	12
Loss at 500 rev.		45	50	40	40
Air voids content (%) [c, e]	CT 367	4 ± 2	4 ± 2	Specification ± 2	--
Fine aggregate angularity (% min.)	AASHTO T 304, Method A	Report only	Report only	Report only	--
Flat and elongated particles (% max. by mass @ 5:1)	ASTM D 4791	Report only	Report only	Report only	Report only
Voids filled with asphalt (%) [f]	LP-3				--
4.75-mm grading		76.0 – 80.0	76.0 – 80.0	Report only	
9.5-mm grading		73.0 – 76.0	73.0 – 76.0		
12.5-mm grading		65.0 – 75.0	65.0 – 75.0		
19-mm grading		65.0 – 75.0	65.0 – 75.0		
Voids in mineral aggregate (% min.) [f]	LP-2				--
4.75-mm grading		17.0	17.0	--	
9.5-mm grading		15.0	15.0	--	
12.5-mm grading		14.0	14.0	18.0 – 23.0 [g]	
19-mm grading		13.0	13.0	18.0 – 23.0 [g]	
Dust proportion [f]	LP-4				--
4.75-mm and 9.5-mm gradings		0.9 – 2.0	0.9 – 2.0	Report only	
12.5-mm and 19-mm gradings		0.6 – 1.3	0.6 – 1.3		

Smoothness	Section 39-1.12	3.66-m straightedge and must-grind	3.66-m straightedge and must-grind	3.66-m straightedge and must-grind	3.66-m straightedge and must-grind
Asphalt binder	Various	Section 92	Section 92	Section 92	Section 92
Asphalt rubber binder	Various	--	--	Section 92-1.02(C) and Section 39-1.02D	Section 92-1.02(C) and Section 39-1.02D
Asphalt modifier	Various	--	--	Section 39-1.02D	Section 39-1.02D
Crumb rubber modifier	Various	--	--	Section 39-1.02D	Section 39-1.02D

[a] The Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.
[b] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[c] The Engineer reports the average of 3 tests from a single split sample.
[d] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 60 °C ±3 °C by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 60 °C for a minimum of 2 hours and not more than 3 hours."
[e] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[f] Report only if the adjustment for asphalt binder content target value is less than ± 0.3 percent from OBC.
[g] Voids in mineral aggregate for RHMA-G must be within this range.

No single test result may represent more than the smaller of 680 tonnes or 1 day's production.
For any single quality characteristic except smoothness, if 2 consecutive acceptance test results do not comply with the specifications:

1. Stop production.
2. Take corrective action.
3. In the Engineer's presence, take samples and split each sample into 4 parts. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Engineer tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

39-3.03 SPREADING AND COMPACTING EQUIPMENT

Each paver spreading HMA Type A and Type B must be followed by 3 rollers:

1. One vibratory roller specifically designed to compact HMA. The roller must be capable of at least 2,500 vibrations per minute and must be equipped with amplitude and frequency controls. The roller's gross static mass must be at least 6.8 tonnes.
2. One oscillating type pneumatic-tired roller at least 1.2 m wide. Pneumatic tires must be of equal size, diameter, type, and ply. The tires must be inflated to 415 kilopascals minimum and maintained so that the air pressure does not vary more than 35 kilopascals.
3. One steel-tired, 2-axle tandem roller. The roller's gross static mass must be at least 6.8 tonnes.

Each roller must have a separate operator. Rollers must be self-propelled and reversible.
Compact RHMA-G under the specifications for compacting HMA Type A and Type B except do not use pneumatic-tired rollers.
Compact OGFC with steel-tired, 2-axle tandem rollers. If placing over 272 tonnes of OGFC per hour, use at least 3 rollers for each paver. If placing less than 272 tonnes of OGFC per hour, use at least 2 rollers for each paver. Each roller must weigh between 2250 kilograms to 3075 kilograms per linear meter of drum width. Turn the vibrator off.

39-3.04 TRANSPORTING, SPREADING, AND COMPACTING

Pave HMA in maximum 75-mm thick compacted layers.
If the surface to be paved is both in sunlight and shade, pavement surface temperatures are taken in the shade.
Spread HMA Type A and Type B only if atmospheric and surface temperatures are:

Minimum Atmospheric and Surface Temperatures

Compacted Layer Thickness, mm	Atmospheric,° F		Surface,° F	
	Unmodified Asphalt Binder	Modified Asphalt	Unmodified Asphalt Binder	Modified Asphalt Binder [a]
< 45	12.8	10.0	15.6	12.8
45 – 75	7.2	7.2	10.0	10.0

Note:
[a] Except asphalt rubber binder.

If the asphalt binder for HMA Type A and Type B is:

1. Unmodified asphalt binder, complete:
   - 1.1. First coverage of breakdown compaction before the surface temperature drops below 120 °C
   - 1.2. Breakdown and intermediate compaction before the surface temperature drops below 95 °C
   - 1.3. Finish compaction before the surface temperature drops below 65 °C

2. Modified asphalt binder, complete:
   - 2.1. First coverage of breakdown compaction before the surface temperature drops below 115 °C
   - 2.2. Breakdown and intermediate compaction before the surface temperature drops below 85 °C
   - 2.3. Finish compaction before the surface temperature drops below 60 °C

For RHMA-G:

1. Only spread and compact if the atmospheric temperature is at least 12.8 °C and the surface temperature is at least 15.6 °C.

2. Complete the first coverage of breakdown compaction before the surface temperature drops below 140 °C.
3. Complete breakdown and intermediate compaction before the surface temperature drops below 120 °C.
4. Complete finish compaction before the surface temperature drops below 95 °C.
5. If the atmospheric temperature is below 21 °C, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For OGFC with unmodified asphalt binder:

1. Only spread and compact if the atmospheric temperature is at least 12.8 °C and the surface temperature is at least 15.6 °C.
2. Complete first coverage using 2 rollers before the surface temperature drops below 115 °C.
3. Complete all compaction before the surface temperature drops below 95 °C.
4. If the atmospheric temperature is below 21 °C, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For OGFC with modified asphalt binder except asphalt rubber binder:

1. Only spread and compact if the atmospheric temperature is at least 10 °C and the surface temperature is at least 10 °C.
2. Complete first coverage using 2 rollers before the surface temperature drops below 115 °C.
3. Complete all compaction before the surface temperature drops below 85 °C.
4. If the atmospheric temperature is below 21 °C, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For RHMA-O and RHMA-O-HB:

1. Only spread and compact if the atmospheric temperature is at least 12.8 °C and surface temperature is at least 15.6 °C.
2 Complete the 1st coverage using 2 rollers before the surface temperature drops below 140 °C.
3. Complete compaction before the surface temperature drops below 120 °C.
4. If the atmospheric temperature is below 21 °C, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until the mixture is transferred to the paver's hopper or to the pavement surface.

For RHMA-G and OGFC, tarpaulins are not required if the time from discharge to truck until transfer to the paver's hopper or the pavement surface is less than 30 minutes.
HMA compaction coverage is the number of passes needed to cover the paving width. A pass is 1 roller's movement parallel to the paving in either direction. Overlapping passes

are part of the coverage being made and are not a subsequent coverage. Do not start a coverage until completing the prior coverage.
Start rolling at the lower edge and progress toward the highest part.
Perform breakdown compaction of each layer of HMA Type A, Type B, and RHMA-G with 3 coverages using a vibratory roller. The speed of the vibratory roller in kilometers per hour must not exceed the vibrations per minute divided by 1,600. If the HMA layer thickness is less than 25 mm, turn the vibrator off. The Engineer may order fewer coverages if the HMA layer thickness is less than 45 mm.
Perform intermediate compaction of each layer of HMA Type A and Type B with 3 coverages using a pneumatic-tired roller at a speed not to exceed 8 kilometers per hour.
Perform finish compaction of HMA Type A, Type B, and RHMA-G with 1 coverage using a steel-tired roller.
Compact OGFC with 2 coverages using steel-tired rollers.

39-4 QUALITY CONTROL / QUALITY ASSURANCE

39-4.01 DESCRIPTION

If HMA is specified as Quality Control / Quality Assurance, construct it under Section 39-1, "General," this Section 39-4, "Quality Control / Quality Assurance," and Section 39-5, "Measurement and Payment."

39-4.02 GENERAL

The QC / QA construction process consists of:

1. Establishing, maintaining, and changing if needed a quality control system providing assurance the HMA complies with the specifications
2. Sampling and testing at specified intervals, or sublots, to demonstrate compliance and to control process
3. The Engineer sampling and testing at specified intervals to verify testing process and HMA quality
4. The Engineer using test results, statistical evaluation of verified quality control tests, and inspection to accept HMA for payment

A lot is a quantity of HMA. The Engineer designates a new lot when:

1. 20 sublots are complete
2. The JMF changes
3. Production stops for more than 30 days

Each lot consists of no more than 20 sublots. A sublot is 680 tonnes except HMA paved at day's end greater than 225 tonnes is a sublot. If HMA paved at day's end is less than 225 tonnes, you may either make this quantity a sublot or include it in the previous sublot's test results for statistical evaluation.

39-4.03 CONTRACTOR QUALITY CONTROL

39-4.03A GENERAL

Use a composite quality factor, QF_C, and individual quality factors, QF_{QCi}, to control your process and evaluate quality control program. For quality characteristics without quality factors, use your quality control plan's action limits to control process.
Control HMA quality including:

1. Materials
2. Proportioning
3. Spreading and compacting
4. Finished roadway surface

Develop, implement, and maintain a quality control program that includes:

1. Inspection
2. Sampling
3. Testing

39-4.03B QUALITY CONTROL PLAN

With the JMF submittal, submit a written Quality Control Plan (QCP). The QCP must comply with the Department's Quality Control Manual for Hot Mix Asphalt Production and Placement. Discuss the QCP with the Engineer during the prepaving conference. The Engineer reviews each QCP within 5 business days from the submittal. Hold HMA production until the Engineer accepts the QCP in writing. The Engineer's QCP acceptance does not mean your compliance with the QCP will result in acceptable HMA. Section 39-1.05, "Engineer's Acceptance," specifies HMA acceptance.
The QCP must include the name and qualifications of a Quality Control Manager. The Quality Control Manager administers the QCP and during paving must be at the job site within 3 hours of receiving notice. The Quality Control Manager must not be any of the following on the project:

1. Foreman
2. Production or paving crewmember
3. Inspector
4. Tester

The QCP must include action limits and details of corrective action you will take if a test result for any quality characteristic falls outside an action limit.
As work progresses, you must submit a written QCP supplement to change quality control procedures, personnel, tester qualification status, or laboratory accreditation status.

39-4.03C QUALITY CONTROL INSPECTION, SAMPLING, AND TESTING

Sample, test, inspect, and manage HMA quality control.
Provide a roadway inspector while HMA paving activities are in progress. Provide a plant inspector during HMA production.

Inspectors must comply with the Department's Quality Control Manual for Hot Mix Asphalt Production and Placement.

Provide a testing laboratory and personnel for quality control testing. Provide the Engineer unrestricted access to the quality control activities. Before providing services for the project, the Engineer reviews, accredits, and qualifies the testing laboratory and personnel under the Department's Independent Assurance Program.

The minimum random sampling and testing for quality control is:

Minimum Quality Control – QC / QA

Quality Characteristic	Test Method	Minimum Sampling and Testing Frequency	HMA Type A	HMA Type B	HMA Type RHMA-G	Location of Sampling	Maximum Reporting Time Allowance
Aggregate gradation [a]	CT 202		JMF ± Tolerance [b]	JMF ± Tolerance [b]	JMF ± Tolerance [b]	CT 125	
Asphalt binder content (%)	CT 379 or 382	1 per 680 tonnes	JMF ±0.45	JMF ±0.45	JMF ±0.5	Loose Mix Behind Paver See CT 125	24 hours
Percent of maximum theoretical density (%) [c, d]	QC Plan		92 - 96	92 - 96	91 - 96	QC Plan	
Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants [e]	CT 226 or CT 370	2 per day during production	--	--	--	Stockpiles or cold feed belts	--
Sand equivalent (min.) [f]	CT 217	1 per 680 tonnes	47	42	47	CT 125	24 hours
HMA moisture content (%, max.)	CT 226 or CT 370	1 per 2250 tonnes but not less than 1 per paving day	1.0	1.0	1.0		24 hours
Stabilometer Value (min.) [f, h] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings	CT 366	1 per 3600 tonnes or 2 per 5 business days, whichever is more	 30 37	 30 35	 -- 23	Loose Mix Behind Paver See CT 125	48 hours
Air voids content (%) [f, h]	CT 367		4 ± 2	4 ± 2	Specification ± 2		

Percent of crushed particles coarse aggregate (% min.) One fractured face Two fractured faces Fine aggregate (% min) (Passing 4.75-mm sieve and retained on 2.36-mm sieve.) One fractured face	CT 205	As neces-sary and designat-ed in QCP. At least once per project.	90 75 70	25 -- 20	-- 90 70	CT 125	48 hours
Los Angeles Rattler (% max.) Loss at 100 rev. Loss at 500 rev.	CT 211		12 45	-- 50	12 40	CT 125	
Fine aggregate angularity (% min.)	AASHTO T 304, Method A		Report only	Report only	Report only	CT 125	
Flat and elongated particle (% max. by mass @ 5:1)	ASTM D 4791					CT 125	
Voids filled with asphalt (%) [i] 4.75-mm grading 9.5-mm grading 12.5-mm grading 19-mm grading	LP-2		76.0 – 80.0 73.0 – 76.0 65.0 – 75.0 65.0 – 75.0	76.0 – 80.0 73.0 – 76.0 65.0 – 75.0 65.0 – 75.0		LP-2	
Voids in mineral aggregate (% min.) [i] 4.75-mm grading 9.5-mm grading 12.5-mm grading 19-mm grading	LP-3		17.0 15.0 14.0 13.0	17.0 15.0 14.0 13.0	-- -- 18.0 – 23. 18.0 – 23.	LP-3	
Dust proportion [i] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings	LP-4		0.9 – 2.0 0.6 – 1.3	0.9 – 2.0 0.6 – 1.3	Report only	LP-4	
Smoothness	Section 39-1.12	--	3.66-m straight-edge, must-grind, and	3.66-m straight-edge, must-grind, and	3.66-m straight-edge, must-grind, and	--	
Asphalt rubber binder viscosity @ 177 °C, centipoises	Section 39-1.02D	--	--	--	1,500 – 4,000	Section 39-1.02D	24 hours
Crumb rubber modifier	Section 39-1.02D	--	--	--	Section 39-1.02D	Section 39-1.02D	48 hours

Notes:
[a] Determine combined aggregate gradation containing RAP under Laboratory Procedure LP-9.
[b] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."

[c] Required for HMA Type A, Type B, and RHMA-G if the total paved thickness is at least 45 mm.
[d] Determine maximum theoretical density (California Test 309) at the frequency specified for test maximum density under California Test 375, Part 5 D.
[e] For adjusting the plant controller at the HMA plant.
[f] Report the average of 3 tests from a single split sample.
[g] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 60 °C ± 3 °C by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 60 °C for a minimum of 2 hours and not more than 3 hours."
[h] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for asphalt binder content target value is less than ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

Within the specified reporting time, submit written test results including:

1. Sampling location, quantity, and time
2. Testing results
3. Supporting data and calculations

If test results for any quality characteristic are beyond the action limits in the QCP, take corrective actions. Document the corrective actions taken in the inspection records under Section 39-4.03E, "Records of Inspection and Testing."
Stop production, notify the Engineer in writing, take corrective action, and demonstrate compliance with the specifications before resuming production and placement on the State highway if:

1. A lot's composite quality factor, , or an individual quality factor, for i = 3, 4, or 5, is below 0.90 determined under Section 39-4.03F, "Statistical Evaluation"
2. An individual quality factor, for i = 1 or 2, is below 0.75
3. Quality characteristics for which a quality factor, , is not determined has 2 consecutive acceptance or quality control tests not in compliance with the specifications

39-4.03D CHARTS AND RECORDS

Record sampling and testing results for quality control on forms provided in the "Quality Control Manual for Hot Mix Asphalt Production and Placement," or on forms you submit with the QCP. The QCP must also include form posting locations and submittal times. Submit quality control test results using the Department's statistical evaluation program, HMAPay, available at

www.dot.ca.gov/hq/construc/hma/index.htm

39-4.03E RECORDS OF INSPECTION AND TESTING

During HMA production, submit in writing a daily:

1. HMA Construction Daily Record of Inspection. Also make this record available at the HMA plant and job site each day.
2. HMA Inspection and Testing Summary. Include in the summary:

2.1. Test forms with the testers' signatures and Quality Control Manager's initials.
2.2. Inspection forms with the inspectors' signatures and Quality Control Manager's initials.
2.3. A list and explanation of deviations from the specifications or regular practices.
2.4. A signed statement by the Quality Control Manager that says:

"It is hereby certified that the information contained in this record is accurate, and that information, tests, or calculations documented herein comply with the specifications of the contract and the standards set forth in the testing procedures. Exceptions to this certification are documented as part of this record."

Retain for inspection the records generated as part of quality control including inspection, sampling, and testing for at least 3 years after final acceptance.

39-4.03F STATISTICAL EVALUATION

General

Determine a lot's composite quality factor, QF_C, and the individual quality factors, QF_{QCi}. Perform statistical evaluation calculations to determine these quality factors based on quality control test results for:

1. Aggregate gradation
2. Asphalt binder content
3. Percent of maximum theoretical density

The Engineer grants a waiver and you must use 1.0 as the individual quality factor for percent of maximum theoretical density, QF_{QC5}, for HMA paved in:

1. Areas where the total paved thickness is less than 45 mm
2. Areas where the total paved thickness is less than 60 mm and a 19-mm grading is specified and used
3. Dig outs
4. Leveling courses
5. Detours not part of the finished roadway prism
6. Areas where, in the opinion of the Engineer, compaction or compaction measurement by conventional methods is impeded

Statistical Evaluation Calculations

Use the Variability-Unknown / Standard Deviation Method to determine the percentage of a lot not in compliance with the specifications. The number of significant figures used in the calculations must comply with AASHTO R-11, Absolute Method.

Determine the percentage of work not in compliance with the specification limits for each quality characteristic as follows:

1. Calculate the arithmetic mean ($\bar{X}$) of the test values

$$\bar{X} = \frac{\Sigma x}{n}$$

where:

x = individual test values
n = number of test values

2. Calculate the standard deviation

$$s = \sqrt{\frac{n(\Sigma x^2) - (\Sigma x)^2}{n(n-1)}}$$

where:

$\sum()$ = sum of the squares of individual test values
$(\sum x)^2$ = sum of the individual test values squared
n = number of test values

3. Calculate the upper quality index (Qu)

$$Q_u = \frac{USL - \bar{X}}{s}$$

where:

USL = target value plus the production tolerance or upper specification limit
s = standard deviation
$\bar{X}$ = arithmetic mean

4. Calculate the lower quality index (QL);

$$Q_L = \frac{\bar{X} - LSL}{s}$$

where:

LSL = target value minus production tolerance or lower specification limit
s = standard deviation
$\bar{X}$ = arithmetic mean

5. From the table, Upper Quality Index or Lower Quality Index , of this Section 39-4.03F, "Statistical Evaluation", determine ;

where:

= the estimated percentage of work outside the USL.

= 0, when USL is not specified.

6. From the table, Upper Quality Index or Lower Quality Index , of this Section 39-4.03F, "Statistical Evaluation," determine ;

where:

= the estimated percentage of work outside the LSL.
= 0, when LSL is not specified.

7. Calculate the total estimated percentage of work outside the USL and LSL, percent defective

   Percent defective = +

P_U and P_L are determined from:

or	**Upper Quality Index or Lower Quality Index**												
	Sample Size (n)												
	5	6	7	8	9	10-11	12-14	15-17	18-22	23-29	30-42	43-66	>66
0	1.72	1.88	1.99	2.07	2.13	2.20	2.28	2.34	2.39	2.44	2.48	2.51	2.56
1	1.64	1.75	1.82	1.88	1.91	1.96	2.01	2.04	2.07	2.09	2.12	2.14	2.16
2	1.58	1.66	1.72	1.75	1.78	1.81	1.84	1.87	1.89	1.91	1.93	1.94	1.95
3	1.52	1.59	1.63	1.66	1.68	1.71	1.73	1.75	1.76	1.78	1.79	1.80	1.81
4	1.47	1.52	1.56	1.58	1.60	1.62	1.64	1.65	1.66	1.67	1.68	1.69	1.70
5	1.42	1.47	1.49	1.51	1.52	1.54	1.55	1.56	1.57	1.58	1.59	1.59	1.60
6	1.38	1.41	1.43	1.45	1.46	1.47	1.48	1.49	1.50	1.50	1.51	1.51	1.52
7	1.33	1.36	1.38	1.39	1.40	1.41	1.41	1.42	1.43	1.43	1.44	1.44	1.44
8	1.29	1.31	1.33	1.33	1.34	1.35	1.35	1.36	1.36	1.37	1.37	1.37	1.38
9	1.25	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.31	1.31	1.31	1.31
10	1.21	1.23	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.26	1.26
11	1.18	1.18	1.19	1.19	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20
12	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
13	1.10	1.10	1.10	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11
14	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
15	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
16	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
17	0.97	0.96	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94
18	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90
19	0.90	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
20	0.87	0.86	0.85	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83
21	0.84	0.82	0.82	0.81	0.81	0.81	0.80	0.80	0.80	0.80	0.80	0.80	0.79
22	0.81	0.79	0.79	0.78	0.78	0.77	0.77	0.77	0.76	0.76	0.76	0.76	0.76
23	0.77	0.76	0.75	0.75	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73
24	0.74	0.73	0.72	0.72	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.70	0.70
25	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.67	0.67	0.66
26	0.68	0.67	0.67	0.65	0.65	0.65	0.64	0.64	0.64	0.64	0.64	0.64	0.63
27	0.65	0.64	0.63	0.62	0.62	0.62	0.61	0.61	0.61	0.61	0.61	0.61	0.60
28	0.62	0.61	0.60	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.58	0.58	0.57
29	0.59	0.58	0.57	0.57	0.56	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.54
30	0.56	0.55	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52
31	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.49	0.49	0.49	0.49	0.49	0.49
32	0.50	0.49	0.48	0.48	0.48	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.46
33	0.47	0.48	0.45	0.45	0.45	0.44	0.44	0.44	0.44	0.43	0.43	0.43	0.43
34	0.45	0.43	0.43	0.42	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.40
35	0.42	0.40	0.40	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.38	0.38
36	0.39	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
37	0.36	0.35	0.34	0.34	0.34	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.32
38	0.33	0.32	0.32	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30
39	0.30	0.30	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
40	0.28	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
41	0.25	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
42	0.23	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
43	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
44	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
45	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
46	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
47	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
48	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
49	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1. If the value of or does not correspond to a value in the table, use the next lower value.

2. If or are negative values, or is equal to 100 minus the table value for or .

Quality Factor Determination

Determine individual quality factors, QF_{QCi}, using percent defective = $P_U + P_L$ and:

Quality Factors

Quality Factor	Maximum Allowable Percent Defective (+)												
	Sample Size (n)												
	5	6	7	8	9	10-11	12-14	15-17	18-22	23-29	30-42	43-66	>66
1.05				0	0	0	0	0	0	0	0	0	0
1.04			0	1	3	5	4	4	4	3	3	3	3
1.03		0	2	4	6	8	7	7	6	5	5	4	4
1.02		1	3	6	9	11	10	9	8	7	7	6	6
1.01	0	2	5	8	11	13	12	11	10	9	8	8	7
1.00	22	20	18	17	16	15	14	13	12	11	10	9	8
0.99	24	22	20	19	18	17	16	15	14	13	11	10	9
0.98	26	24	22	21	20	19	18	16	15	14	13	12	10
0.97	28	26	24	23	22	21	19	18	17	16	14	13	12
0.96	30	28	26	25	24	22	21	19	18	17	16	14	13
0.95	32	29	28	26	25	24	22	21	20	18	17	16	14
0.94	33	31	29	28	27	25	24	22	21	20	18	17	15
0.93	35	33	31	29	28	27	25	24	22	21	20	18	16
0.92	37	34	32	31	30	28	27	25	24	22	21	19	18
0.91	38	36	34	32	31	30	28	26	25	24	22	21	19
0.90	39	37	35	34	33	31	29	28	26	25	23	22	20
0.89	41	38	37	35	34	32	31	29	28	26	25	23	21
0.88	42	40	38	36	35	34	32	30	29	27	26	24	22
0.87	43	41	39	38	37	35	33	32	30	29	27	25	23
0.86	45	42	41	39	38	36	34	33	31	30	28	26	24
0.85	46	44	42	40	39	38	36	34	33	31	29	28	25
0.84	47	45	43	42	40	39	37	35	34	32	30	29	27
0.83	49	46	44	43	42	40	38	36	35	33	31	30	28
0.82	50	47	46	44	43	41	39	38	36	34	33	31	29
0.81	51	49	47	45	44	42	41	39	37	36	34	32	30
0.80	52	50	48	46	45	44	42	40	38	37	35	33	31
0.79	54	51	49	48	46	45	43	41	39	38	36	34	32
0.78	55	52	50	49	48	46	44	42	41	39	37	35	33
0.77	56	54	52	50	49	47	45	43	42	40	38	36	34
0.76	57	55	53	51	50	48	46	44	43	41	39	37	35
0.75	58	56	54	52	51	49	47	46	44	42	40	38	36
	60	57	55	53	52	51	48	47	45	43	41	40	37
	61	58	56	55	53	52	50	48	46	44	43	41	38
Reject	62	59	57	56	54	53	51	49	47	45	44	42	39
	63	61	58	57	55	54	52	50	48	47	45	43	40
	64	62	60	58	57	55	53	51	49	48	46	44	41
Reject Values Greater Than Those Shown Above													

Notes:

1. To obtain a quality factor when the estimated percent outside specification limits from table, "Upper Quality Index or Lower Quality Index ," does not correspond to a value in the table, use the next larger value.

Compute the composite of single quality factors, , for a lot using:

$$QF_C = \sum_{i=1}^{5} w_i \, QF_{QC_i}$$

where:

=	the composite quality factor for the lot rounded to 2 decimal places.
=	the quality factor for the individual quality characteristic.
w =	the weighting factor listed in the table HMA Acceptance – QC / QA.
i =	the quality characteristic index number in the table HMA Acceptance – QC / QA.

39-4.04 ENGINEER'S QUALITY ASSURANCE

39-4.04A GENERAL

The Engineer assures quality by:

1. Reviewing mix designs and proposed JMF
2. Inspecting procedures
3. Conducting oversight of quality control inspection and records
4. Verification sampling and testing during production and paving

39-4.04B VERIFICATION SAMPLING AND TESTING

General

The Engineer samples:

1. Aggregate to verify gradation
2. HMA to verify asphalt binder content

Verification

For aggregate gradation and asphalt binder content, the ratio of verification testing frequency to the minimum quality control testing frequency is 1:5. The Engineer performs at least 3 verification tests per lot.

Using the t-test, the Engineer compares quality control tests results for aggregate gradation and asphalt binder content with corresponding verification test results. The Engineer uses the average and standard deviation of up to 20 sequential sublots for the comparison. When there are less than 20 sequential sublots, the Engineer uses the maximum number of sequential sublots available. The 21st sublot becomes the 1st sublot (n = 1) in the next lot.

The t-value for a group of test data is computed as follows:

$$t = \frac{\left|\overline{X}_c - \overline{X}_v\right|}{S_p\sqrt{\frac{1}{n_c} + \frac{1}{n_v}}} \qquad \text{and} \qquad S_p^2 = \frac{S_c^2(n_c - 1) + S_v^2(n_v - 1)}{n_c + n_v - 2}$$

where:

= Number of quality control tests (2 minimum, 20 maximum).
= Number of verification tests (minimum of 1 required).
$\overline{X}_c$ = Mean of quality control tests.
$\overline{X}_v$ = Mean of verification tests.
= Pooled standard deviation (When = 1, =).
= Standard deviation of quality control tests.
= Standard deviation of verification tests (when > 1).

The comparison of quality control test results and the verification test results is at a level of significance of α = 0.025. The Engineer computes t and compares it to the critical t-value, t_{crit}, from:

Critical T-Value

Degrees of freedom (+ -2)	(for α = 0.025)	Degrees of freedom (+ -2)	(for α = 0.025)
1	24.452	18	2.445
2	6.205	19	2.433
3	4.177	20	2.423
4	3.495	21	2.414
5	3.163	22	2.405
6	2.969	23	2.398
7	2.841	24	2.391
8	2.752	25	2.385
9	2.685	26	2.379
10	2.634	27	2.373
11	2.593	28	2.368
12	2.560	29	2.364
13	2.533	30	2.360
14	2.510	40	2.329
15	2.490	60	2.299
16	2.473	120	2.270
17	2.458	∞	2.241

If the t-value computed is less than or equal to t_{crit}, quality control test results are verified. If the t-value computed is greater than t_{crit} and both $\overline{X}_v$ and $\overline{X}_c$ comply with acceptance specifications, the quality control tests are verified. You may continue to produce and place HMA with the following allowable differences:

1. $\left|\overline{X}_v - \overline{X}_c\right| \leq 1.0$ percent for any grading
2. $\left|\overline{X}_v - \overline{X}_c\right| \leq 0.1$ percent for asphalt binder content

If the t-value computed is greater than t_{crit} and the $\left|\overline{X}_v - \overline{X}_c\right|$ for grading and asphalt binder content are greater than the allowable differences, quality control test results are not verified and:

1. The Engineer notifies you in writing.
2. You and the Engineer must investigate why the difference exist.
3. If the reason for the difference cannot be found and corrected, the Engineer's test results are used for acceptance and pay.

39-4.05 ENGINEER'S ACCEPTANCE

39-4.05A TESTING

The Engineer samples for acceptance testing and tests for:

HMA Acceptance – QC / QA

Index (i)	Quality Characteristic				Weight-ing Factor (w)	Test Method	HMA Type		
							A	B	RHMA-G
		Aggregate gradation [a]							
	Sieve	3/4"	1/2"	3/8"					
1	12.5-mm	X [b]	--	--	0.05	CT 202	JMF ± Tolerance [c]		
1	9.5-mm	--	X	--	0.05				
1	4.75-mm	--	--	X	0.05				
2	2.36-mm	X	X	X	0.10				
3	0.075-mm	X	X	X	0.15				
4	Asphalt binder content (%)				0.30	CT 379 or 382	JMF ± 0.45	JMF ± 0.45	JMF ± 0.5
5	Percent of maximum theoretical density (%) [d, e]				0.40	CT 375	92 – 96	92 – 96	91 – 96
	Sand equivalent (min.) [f]					CT 217	47	42	47
	Stabilometer value (min.) [f, g] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings					CT 366	 30 37	 30 35	 -- 23
	Air voids content (%) [f, h]					CT 367	4 ± 2	4 ± 2	Specification ± 2
	Percent of crushed particles coarse aggregate (% min.) One fractured face Two fractured faces Fine aggregate (% min) (Passing 4.75-mm sieve and retained on 2.36-mm sieve.) One fractured face					CT 205	 90 70 70	 25 -- 20	 -- 90 70
	HMA moisture content (%, max.)					CT 226 or CT 370	1.0	1.0	1.0
	Los Angeles Rattler (% max.) Loss at 100 rev. Loss at 500 rev.					CT 211	 12 45	 -- 50	 12 45
	Fine aggregate angularity (% min.)					AASHTO T 304, Method A	Report only	Report only	Report only
	Flat and elongated particle (% max. by mass @ 5:1)					ASTM D 4791	Report only	Report only	Report only
	Voids in mineral aggregate (% min.) [i] 4.75-mm grading 9.5-mm grading 12.5-mm grading 19-mm grading					LP-2	 17.0 15.0 14.0 13.0	 17.0 15.0 14.0 13.0	(Note j) -- -- 18.0 - 23.0 18.0 - 23.0

	Voids filled with asphalt (%) [i] 4.75-mm grading 9.5-mm grading 12.5-mm grading 19-mm grading		LP-3	76.0 - 80.0 73.0 - 76.0 65.0 - 75.0 65.0 - 75.0	76.0 - 80.0 73.0 - 76.0 65.0 - 75.0 65.0 - 75.0	Report only
	Dust proportion [i] 4.75-mm and 9.5-mm gradings 12.5-mm and 19-mm gradings		LP-4	0.9 - 2.0 0.6 - 1.3	0.9 – 2.0 0.6 – 1.3	Report only
	Smoothness		Section 39-1.12	3.66-m straight-edge, must-grind, and	3.66-m straight-edge, must-grind, and	3.66-m straight-edge, must-grind, and
	Asphalt binder		Various	Section 92	Section 92	Section 92
	Asphalt rubber binder		Various	--	--	Section 92-1.02(C) and Section 39-1.02D
	Asphalt modifier		Various	--	--	Section 39-1.02D
	Crumb rubber modifier		Various	--	--	Section 39-1.02D

Notes:
[a] The Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.
[b] "X" denotes the sieves the Engineer considers for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[d] The Engineer determines percent of maximum theoretical density if the total paved thickness is at least 45 mm under California Test 375 except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[e] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] The Engineer reports the average of 3 tests from a single split sample.
[g] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 60 °C ± 3 °C by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 60 °C for a minimum of 2 hours and not more than 3 hours."
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i.] Report only if the adjustment for asphalt binder content target value is less than ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

The Engineer determines the percent of maximum theoretical density from the average density of 3 cores you take from every 680 tonnes of production or part thereof divided by the maximum theoretical density.
If the total paved thickness is at least 45 mm and any layer is less than 45 mm, the Engineer determines the percent of maximum theoretical density from cores taken from the final layer measured the full depth of the total paved HMA thickness.
The Engineer stops production and terminates a lot if:

1. The lot's composite quality factor, , or an individual quality factor, for i = 3, 4, or 5, is below 0.90 determined under Section 39-4.03F, "Statistical Evaluation"
2. An individual quality factor, for i = 1 or 2, is below 0.75
3. Quality characteristics for which a quality factor, , is not determined has 2 consecutive acceptance or quality control tests not in compliance with the specifications

For any single quality characteristic for which a quality factor, QF_{QCi}, is not determined, except smoothness, if 2 consecutive acceptance test results do not comply with specifications:

1. Stop production.
2. Take corrective action.
3. In the Engineer's presence, take samples and split each sample into 4 parts. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Engineer tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

39-4.05B STATISTICAL EVALUATION, DETERMINATION OF QUALITY FACTORS AND ACCEPTANCE

Statistical Evaluation and Determination of Quality Factors

To determine the individual quality factor, $QF_{QCi,}$ for any quality factor i = 1 through 5 or a lot's composite quality factor, QF_C, for acceptance and payment adjustment, the Engineer uses the evaluation specifications under Section 39-4.03F, "Statistical Evaluation," and:

1. Verified quality control test results for aggregate gradation
2. Verified quality control test results for asphalt binder content
3. The Engineer's test results for percent of maximum theoretical density

Lot Acceptance Based on Quality Factors

The Engineer accepts a lot based on the quality factors determined for aggregate gradation and asphalt binder content, QF_{QCi} for i = 1 through 4, using the total number of verified quality control test result values and the total percent defective ($P_U + P_L$).
The Engineer accepts a lot based on the quality factor determined for maximum theoretical density, QF_{QC5}, using the total number of test result values from cores and the total percent defective ($P_U + P_L$).
The Engineer calculates the quality factor for the lot, QF_C, which is a composite of weighted individual quality factors, QF_{QCi}, determined for each quality characteristic in the table "HMA Acceptance – QC / QA" in Section 39-4.05A, "Testing."
The Engineer accepts a lot based on quality factors if:

1. The current composite quality factor, , is 0.90 or greater

2. Each individual quality factor, for i = 3, 4, and 5, is 0.90 or greater
3. Each individual quality factor, for i = 1 and 2, is 0.75 or greater

No single quality characteristic test may represent more than the smaller of 680 tonnes or 1 day's production.

Payment Adjustment

If a lot is accepted, the Engineer adjusts payment with the following formula:

$$PA = \sum_{i=1}^{n} HMACP * w_i * \left[QF_{QCi} * (HMATT - WHMATT_i) + WHMATT_i\right] - (HMACP * HMATT)$$

where:

PA =	Payment adjustment rounded to 2 decimal places.
HMACP =	HMA contract price.
HMATT =	HMA total tonnes represented in the lot.
=	Total tonnes of waived quality characteristic HMA.
=	Running quality factor for the individual quality characteristic. for i = 1 through 4 must be from verified Contractor's QC results. must be determined from the Engineer's results on cores taken for percent of maximum theoretical density determination.
w =	Weighting factor listed in the HMA acceptance table.
i =	Quality characteristic index number in the HMA acceptance table.

If the payment adjustment is a negative value, the Engineer deducts this amount from payment. If the payment adjustment is a positive value, the Engineer adds this amount to payment.
The 21st sublot becomes the 1st sublot (n = 1) in the next lot. When the 21st sequential sublot becomes the 1st sublot, the previous 20 sequential sublots become a lot for which the Engineer determines a quality factor. The Engineer uses this quality factor to pay for the HMA in the lot. If the next lot consists of less than 8 sublots, these sublots must be added to the previous lot for quality factor determination using 21 to 27 sublots.

39-4.05C DISPUTE RESOLUTION

For a lot, if you or the Engineer dispute any quality factor, QF_{QCi}, or verification test result, every sublot in that lot must be retested.
Referee tests must be performed under the specifications for acceptance testing.
Any quality factor, QF_{QCi}, must be determined using the referee tests.
For any quality factor, QF_{QCi}, for i = 1 through 5, dispute resolution:

1. If the difference between the quality factors for using the referee test result and the disputed test result is less than or equal to 0.01, the original test result is correct.

2. If the difference between the quality factor for using the referee test result and the disputed test result is more than 0.01, the quality factor determined from the referee tests supersedes the previously determined quality factor.

39-5 MEASUREMENT AND PAYMENT

39-5.01 MEASUREMENT

The contract item for HMA is measured by mass. The mass of each HMA mixture designated in the Engineer's Estimate must be the combined mixture mass.
If tack coat, asphalt binder, and asphaltic emulsion are paid with separate contract items, their contract items are measured under Section 92, "Asphalts," or Section 94, "Asphaltic Emulsions," as the case may be.
If recorded batch mass are printed automatically, the contract item for HMA is measured by using the printed batch mass, provided:

1. Total aggregate and supplemental fine aggregate mass per batch is printed. If supplemental fine aggregate is weighed cumulatively with the aggregate, the total aggregate batch mass must include the supplemental fine aggregate mass.
2. Total asphalt binder mass per batch is printed.
3. Each truckload's zero tolerance mass is printed before weighing the first batch and after weighing the last batch.
4. Time, date, mix number, load number and truck identification is correlated with a load slip.
5. A copy of the recorded batch mass is certified by a licensed weighmaster and submitted to the Engineer.

The contract item for placing HMA dike is measured by the linear meter along the completed length. The contract item for placing HMA in miscellaneous areas is measured as the in-place compacted area in square meters. In addition to the quantities measured on a linear meter or square meter basis, the HMA for dike and miscellaneous areas are measured by mass.
The contract item for shoulder rumble strips is measured by the station along each shoulder on which the rumble strips are constructed without deductions for gaps between indentations.
The contract item for geosynthetic pavement interlayer is measured by the square meter for the actual pavement area covered.

39-5.02 PAYMENT

The contract prices paid per tonne for hot mix asphalt as designated in the Engineer's Estimate include full compensation for furnishing all labor, materials, tools, equipment, and incidentals for doing all the work involved in constructing hot mix asphalt, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.
If HMA is specified to comply with Section 39-4, "Quality Control / Quality Assurance," the Engineer adjusts payment under that section.

Full compensation for the Quality Control Plan and prepaving conference is included in the contract prices paid per tonne for hot mix asphalt as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

Full compensation for performing and submitting mix designs and for Contractor sampling, testing, inspection, testing facilities, and preparation and submittal of results is included in the contract prices paid per tonne for HMA as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

Full compensation for reclaimed asphalt pavement is included in the contract prices paid per tonne for HMA as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

The contract price paid per tonne for hot mix asphalt (leveling) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals for doing all the work involved in hot mix asphalt (leveling), complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The contract prices paid per station for rumble strips as designated in the Engineer's Estimate include full compensation for furnishing all labor, materials, tools, equipment, and incidentals for doing all the work involved in constructing rumble strips, including fog seal coat, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The State will pay for HMA dike at the contract price per linear meter for place HMA dike and by the tonne for HMA. The contract prices paid per linear meter for place hot mix asphalt dike as designated in the Engineer's Estimate include full compensation for furnishing all labor, tools, equipment, and incidentals, and for doing all the work involved in placing HMA dike, complete in place, including excavation, backfill, and preparation of the area to receive the dike, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The State pays for HMA specified to be a miscellaneous area at the contract price per square meter for place hot mix asphalt (miscellaneous area) and per tonne for hot mix asphalt. The contract price paid per square meter for place hot mix asphalt (miscellaneous area) includes full compensation for furnishing all labor, tools, equipment, and incidentals, and for doing all the work involved in placing HMA (miscellaneous area) complete in place, including excavation, backfill, and preparation of the area to receive HMA (miscellaneous area), as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

If the Quality Control / Quality Assurance construction process is specified, HMA placed in dikes and miscellaneous areas is paid for at the contract price per tonne for hot mix asphalt under Section 39-4, "Quality Control / Quality Assurance." Section 39-4.05B, "Statistical Evaluation, Determination of Quality Factors and Acceptance," does not apply to HMA placed in dikes and miscellaneous areas.

If there are no contract items for place hot mix asphalt dike and place hot mix asphalt (miscellaneous area) and the work is specified, full compensation for constructing HMA dikes and HMA (miscellaneous areas) including excavation, backfill, and preparation of the area to receive HMA dike or HMA (miscellaneous area) is included in the contract price paid per tonne for the hot mix asphalt designated in the Engineer's Estimate and no separate payment will be made therefor.

The contract price paid per square meter for geosynthetic pavement interlayer includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in placing geosynthetic pavement interlayer, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The contract price paid per tonne for paving asphalt (binder, geosynthetic pavement interlayer) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying paving asphalt (binder, geosynthetic pavement interlayer), complete in place, including spreading sand to cover exposed binder material, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

Full compensation for small quantities of HMA placed on geosynthetic pavement interlayer to prevent displacement during construction is included in the contract price paid per tonne for the HMA being paved over the interlayer and no separate payment will be made therefor.

The contract price paid per tonne for tack coat includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying tack coat, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

If there is no item for tack coat and the work is specified, full compensation for tack coat is included in the contract price paid per tonne for hot mix asphalt as designated in the Engineer's Estimate and no separate payment will be made therefor.

The Engineer does not adjust payment for increases or decreases in the quantities for tack coat, regardless of the reason for the increase or decrease. Section 4-1.03B, "Increased or Decreased Quantities," does not apply to the items for tack coat.

Full compensation for performing smoothness testing, submitting written and electronic copies of tests, and performing corrective work including applying fog seal coat is included in the contract price paid per tonne for the HMA designated in the Engineer's Estimate and no separate payment will be made therefor.

Full compensation for spreading sand on RHMA-G, RHMA-O, and RHMA-O-HB surfaces and for sweeping and removing excess sand is included in the contract price paid per tonne for rubberized hot mix asphalt as designated in the Engineer's Estimate and no separate payment will be made therefor.

If the Engineer fails to comply with a specification within a specified time, and if, in the opinion of the Engineer, work completion is delayed because of the failure, the Engineer adjusts payment and contract time under Section 8-1.09, "Right of Way Delays."

If the dispute resolution ITP determines the Engineer's test results are correct, the Engineer deducts the ITP's testing costs from payments. If the ITP determines your test results are correct, the State pays the ITP's testing costs. If, in the Engineer's opinion, work completion is delayed because of incorrect Engineer test results, the Engineer adjusts payment and contract time under Section 8-1.09, "Right of Way Delays."

^^

APPENDIX G1

State Test Case #7, Montana:

MDT SECTION 401-1c

Airport Pavement for <60,000# AGW

SUPERPAVE ASPHALT CONCRETE, inclusive, and all other referenced parts of Montana Department of Transportation, Special Provisions (Revised 12-19-07) to Standard Specifications for Road and Bridge Construction, 2006 Edition, are applicable under this SECTION 401-1c, except as modified herein.

Equivalent Terms for this Specification, and throughout application of Montana Department of Transportation, Standard Specifications for Road and Bridge Construction, 2006 Edition, are listed below:

Department, synonymous with Airport Owner [or Owner Authorized Representative]

Engineer or Project Manager, synonymous with Airport Owner [or Owner Authorized Representative]

Roadway, synonymous with Airport Pavement

401-1c Plant Mix Bituminous Surfacing – Grade S Volumetric Acceptance (Revised 12-19-07)

1. PLANT MIX BITUMINOUS SURFACING - GRADE S VOLUMETRIC ACCEPTANCE [401] (Revised 12-19-07)

Delete Subsection 1.A and substitute the following:

A. Description. This work is producing, furnishing, placing, and compacting hot mix asphalt pavement. This specification covers ¾ inch (19 mm) and ½ inch (12.5 mm) nominal aggregate size, Grade S plant mix. Provide Grade S plant mix meeting all requirements for the ¾ inch (19 mm) or ½ inch (12.5 mm) nominal aggregate size.

Standard Specifications Sections 401 and 105.03.3 are rescinded. Standard Specification 105.03.2 is rescinded for Cold Feed Aggregate Gradations only.

B. Materials. Furnish aggregate from sources meeting the applicable Section 106 requirements.

Submit four copies of a written Quality Control (QC) Plan to the Project Manager for plant mix aggregate, and plant mix surfacing, before production of each material. It is recommended that the contractor use generally recognized Statistical Quality Control methods and tests. Be responsible for all sampling, testing and control of the aggregate. Furnish the Project Manager four copies of the quality control test results upon request. The program shall address all elements which affect the quality of the pavement including, but not limited to:

- Mix Design
- Aggregate Grading
- Quality of Materials
- Stockpile Management
- Proportioning
- Mixing and Transportation
- Placing and Finishing
- Joints
- Compaction

- Surface Smoothness

Ensure that the aggregate, when combined at the job mix formula, meets Table 701-15B, and applicable subsection 701.03.1 requirements.

It is recommended that at least three separate aggregate stockpiles be produced.

Delete Subsection 1.B.1 and substitute the following:

1) Aggregate Requirements. Meet the following aggregate requirements at the job mix formula combined ratio:

Coarse Aggregate (No. 4 (4.75 mm) and larger)	
Angularity (MT-217 or ASTM D-5821)	See Table 701-15B
Wear (MT-209 or AASHTO T-96)	40% max.
Soundness (ASTM C-88)	10% (sodium sulfate soundness)
	13% (magnesium sulfate soundness)
Flat and Elongated Particles (ASTM D-4791)	
(3:1 Ratio; by mass; No. 4 (4.75 mm) and larger)	20% max.
(5:1 Ratio; by mass; No. 4 (4.75 mm) and larger)	8% max.

Fine Aggregate (No. 8 (2.36 mm) and smaller)	
Angularity (AASHTO T-304 Method A)	45% min.
Sand Equivalent (MT-213 or AASHTO T-176)	45% min.
If aggregate cannot meet the Sand Equivalent, meet the following:	
Volume Swell, untreated aggregates (MT-305)	10% max.
Aggregate must be non-plastic (MT-208 or AASHTO T-89 & T-90)	

2) Hydrated Lime. Furnish hydrated lime meeting subsection 713.02. Include 1.4% hydrated lime by total weight of mix as part of the aggregate gradation.

3) Asphalt Binder. Furnish performance grade asphalt binder meeting Section 702, Table 702-9 and the grade specified in the contract. A PG asphalt binder grade bump is required for facilities designed for aircraft from 12,500 lbs. to 60,000 lbs.

Delete Subsection 1.B.4 and substitute the following:

4) RAP – Recycled Asphalt Pavement. RAP may be incorporated into the mix at a maximum of 15% of the weight of total aggregate for surface courses and 30% for the weight of total aggregate for base, leveling, and shoulder courses. If RAP is included in the job mix formula and the final mix, meet all the Volumetric Grade S requirements in this special provision. Aggregate and asphalt binder requirements 1.B.1 and 1.B.3 apply to virgin materials only. It is recommended that at least two separate RAP stockpiles be produced. The RAP shall not contain any material that has been treated with a coal-tar sealer rejuvenator or material that contains coal-tar.

5) Mix Design and Materials Samples. Submit to the Project Manager four copies of a Superpave volumetric mix design following AASHTO R35 and meeting AASHTO M323, as modified in these provisions. Include the binder supplier's recommended mixing and compaction temperature ranges. Choose the Design Air Voids target to be the lowest value, within the range of 3.4 and 4.0, such that all other volumetric criteria are met. Report the dust/asphalt (D/A) ratio

for the target asphalt content. The mix design is to be produced on a total weight of mix basis. On contracts with multiple gravel sources, or combination of gravel sources, provide a mix design and meet all the requirements in this provision for each source or combination of sources and suppliers. For mix designs using RAP, furnish the RAP asphalt content and the virgin asphalt content and the RAP gradation and the virgin aggregate gradation. Also supply all specific gravities. Furnish quantities from each stockpile to produce an 800-pound (363 kg) sample, when combined at the mix design blend ratio and 5 gallons (19 L) of the PGAB. The Department has thirty calendar days from receipt of the mix design materials and signed mix design documents to review the mix design. Do not begin plant mix production until receiving notification that the Departments mix design verification is complete. The mix design verification consists of passing Hamburg Wheel Track test results and a review of the submitted mix design documents to ensure all applicable design requirements have been met. Contract time will be extended; day for day without any other compensation for Department caused delays beyond the allowed thirty calendar days from receipt of the mix design materials, if the delay affects the start of paving as shown on the contractors work schedules. Contract time will not be extended if the delay occurs between November 1 and April 15.

6) The Department will perform the Hamburg Wheel Track testing and use the test results to verify the plant mix design.

Delete Subsection 1.B.7 and substitute the following:

7) Meet the design requirements in Table 701-15B (2) and Table 701-15B (3).

Table 701-15B (2)

¾ inch (19 mm) and 1/2inch (12.5 mm) Nominal Maximum Aggregate Size) SUPERPAVE VOLUMETRIC MIXTURE DESIGN REQUIREMENTS													
Year Design ESALs		Number of Compactive Gyrations			Percent of Rice			Course Aggregate Angularity 1 face/ 2 face	VMA %		VFA %	VTM % (Air Voids)	[2] (DP) Dust to effective binder ratio
Total (million)	Aircraft Gross Weight (Pounds)	Initial ( )	Design ( )	Max. ( )	Max @	@	Max @		At (Minimum)		At Range	At Range	(P0.075/ Pbe) Range
									19.0 mm	12.5 mm			
< 0.3	<12,500	6	50	75	91.5	96-96.6	98	75/-	≥13.0	≥13.5	70 to 80	3.4 to 4.0	0.6 to 1.6
0.3 to < 3	12,500 to <60,000	7	75	115	90.5	96-96.6	98	85/80	≥13.0	≥13.5	65 to 78	3.4 to 4.0	0.6 to 1.6

Delete note 1 and change note 2 to become note 1.

[2] In addition to meeting the DP requirement at mix design, report the dust/asphalt ratio (D/A) on the mix design.

Table 701-15 B (3)

AGGREGATE DESIGN REQUIREMENTS ¾ inch (19 mm) and 1/2inch (12.5 mm) Nominal Maximum Aggregate Size)						
Percent by Weight Passing Square Mesh Sieves						
	All Pavements Gradation Limits				Primary Control Sieve	
	¾ in (19.0 mm)		½ in (12.5 mm)		¾ in (19.0 mm)	½ in (12.5 mm)
Sieve	Min	Max	Min	Max		
1 inch (25 mm)	100	100	100	100		
¾ inch (19 mm)	76	98	100	100		
½ in (12.5 mm)	66	86	79	99		
3/8 in (9.5 mm)	57	77	68	88		
4 M (4.75 mm)	40	60	48	68	47	
8 M (2.36 mm)	26	46	33	53		39
16 M (1.18 mm)	17	37	20	40		
30 M (0.600 mm)	11	27	14	30		
50 M (0.300 mm)	7	19	9	21		
100M (0.150 mm)	6	16	6	16		
200 M (0.075 mm)	3	6	3	6		
Asphalt Content	4.5	7.0	5.0	7.5		

[1]The combined aggregate gradation is classified as coarse graded when it passes below the Primary Control Sieve (PCS) control point. All other gradations are classified as fine graded.

Use MT 330 to determine the mixture resistance to moisture induced damage, modified as follows:

Compact the 6-inch (150 mm) diameter specimens to 3.75 in. ± 0.20 (95 mm ± 5 mm), at 7 ± 1.0 percent air voids. Meet a tensile strength ratio of 0.7 or greater.

C. Laboratory Testing. The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. It shall be available for joint use by the Contractor for quality control testing and by the Engineer for acceptance testing and must have adequate equipment for the performance of the tests required by these specifications. The Engineer shall have priority in use of the equipment necessary for acceptance testing.

- The effective working area of the laboratory shall be a minimum of 150 square feet with a ceiling height of not less than 7.5 feet. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70 degrees F + 5 degrees.

- Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

Delete Subsection 1.C and substitute the following:

D. Construction Requirements. Produce plant mix meeting Table 701-15 B (2), Table 701-15 B (3), 701-15 D form CB30-QA-VM (S) and the following targets:

701-15 D
GRADE "S" VOLUMETRIC SPECIFICATIONS
¾ inch (19 mm) and 1/2inch (12.5 mm) Nominal Maximum Aggregate Size

Volumetric Property	Job Mix Target Limits		Job Mix Tolerance	Start-up Job Mix Range ***	
Voids in Mineral Aggregate (VMA)	¾ inch (19 mm)	1/2inch (12.5 mm)	± 0.6	¾ inch (19 mm)	1/2inch (12.5 mm)
	13.0 to 17.0	13.5 to 18.0		12.4 to 17.6	12.9 to 18.6
Voids Filled with Asphalt (VFA)	65 to 80		± 5.0	60 to 85	
Voids in Total Mix @ Ndes. (VTM)*	3.4 to 4.0		± 1	2.4 to 5.0	
Dust/Asphalt Ratio (D/A)**	N/A		±0.2	N/A	

* Choose the Design Air Voids target to be the lowest value, within the range in the table above inclusive of 3.4 and 4.0, such that all other volumetric criteria are met.

** Percentages or Quantities of hydrated lime will not be subtracted from the aggregate gradation.

***Start-up job mix range only applies to production before initial target set. Tolerances do not apply to start up job mix range.

Do not begin plant mix paving operations until two working days after the test trailer is made fully operational, (blocked, powered, and acceptable to the Engineer), unless authorized by the Engineer.

Set the initial volumetric job mix targets before producing more than 3000 tons of Plant Mix Surfacing. Plant Mix produced prior to setting initial targets is defined as start-up mix. Furnish the Project Manager four signed copies of form CB30-QA-VM (S) with the proposed job mix targets for Voids in the Mineral Aggregate (VMA), Voids Filled with Asphalt (VFA), Voids in Total Mix (VTM), and Dust to Asphalt Binder Ratio (D/A). Once the job mix targets are set, Quality Assurance (QA) will be applied to all subsequent Grade S material produced. No volumetric pay incentive or disincentive will be applied to the plant mix until the volumetric targets are set. Produce start-up mix meeting the criteria listed under the Start-Up Job Mix Range in table 701-15 D. A Hamburg test will be run when the produced mix does not meet all the criteria specified under the Start-Up Job Mix Range in table 701-15 D.

The contractor may revise the volumetric job mix targets one time during the contract. Submit revised job mix targets no later than 2 days following completion of plant mix production, or initial job mix targets will be used to determine payment. If more than one project is included in the contract (tied projects), the volumetric job mix targets may be revised for each project only if the projects use different mix designs. Submit to the Project Manager four signed copies of form CB30-QA-VM (S) with the revised job mix targets for VMA, VFA, VTM, and D/A. The revised targets will be applied retroactively to all plant mix produced after the initial targets are set, and payment will be recalculated.

No monetary, time or other compensation will be allowed for Department actions required due to the initial targets, (i.e. P-value shutdowns, etc.).

A change in the asphalt supplier or aggregate source(s) will not require a new mix design, provided no change in the established volumetric job mix targets is requested, and the aggregate requirements, and Hamburg Wheel Tracking requirements are met. Provide the apparent and bulk dry specific gravities, and absorption for the aggregate, and the specific gravity for asphalt binder when there are changes in the source(s).

1) Test Procedures. Plant mix will be evaluated using the following test procedures.

MT-303 – Sampling Bituminous Materials
MT 332 – Gyratory Compaction of Bituminous Mixtures
MT 321 – Maximum Specific Gravity of Bituminous Mixtures (Rice Method)
MT-319 – Ignition Oven Burn Procedure
MT 320 – Gradation of Aggregate Recovered by MT 319 Ignition Oven Burn Procedure
MT 330 – Resistance of Bituminous Mixture to Moisture Induced Damage

Delete Subsection 1.C.3 and substitute the following:

2) Items Designated for Acceptance on A Lot Basis (Quality Assurance or QA). The volumetric properties listed in Volumetric Grade S Table 701-15 D are designated for acceptance on a lot-by-lot basis. The elements in the Table 701-15 D are evaluated and the contract items accepted under this specification. The pay factor in Volumetric Grade S Table 701-15 E is applied to plant mix surfacing lots for Voids in the Mineral Aggregate (VMA), Voids Filled with Asphalt (VFA), Voids in Total Mix (VTM), and Dust Asphalt Ratio (D/A). The asphalt content used for volumetric calculations is determined using the asphalt ignition oven test method (MT 319). The Dust Asphalt Ratio (D/A) is calculated based upon test method (MT 319), and the gradation determined using the gradation method (MT 320) on the aggregate remaining after the ignition oven test.

The approximate mix quantity represented by each sub-lot is 1000 tons (1000 metric tons). The quantity represented by 5 tests or approximately 5000 tons (5,000 metric tons) of mix constitutes a lot whenever production schedules and material continuity permit. A lot represented by 3 to 7 consecutive random sub-lots will be established when there are short production runs, significant material changes, or other unusual characteristics of the work

No quality incentive allowance will be applied to plant mix aggregate gradation.

All other contract items are evaluated for acceptance under the applicable specifications covering those items.

Each element of a lot will be evaluated for pay adjustments. The maximum pay factor for the job ~~a lot~~ will be 1.00.

All the individual test results in the lot for the element to be evaluated will be averaged, and the percent of price reduction for the lot determined by the applicable formula.

a) The formula P = (Xn + aR - Tu) x F will be used when the average of the test values is greater than or equal to the job mix target value.

b) The formula P = (TL + aR - Xn) x F will be used when the average of the test values is less than the job mix target value.

P is the percent of reduction in contract price.

Xn is the average of the several test values from samples taken from the lot, with n indicating the number of values.

a is a variable factor to be used as n changes according to the following: when n is 3, a = 0.45; n is 4, a = 0.38; n is 5, a = 0.33; n is 6, a = 0.30; and n is 7, a = 0.28.

R is the difference between the highest and lowest values in the group of test results from the lot.

Tu is the upper or maximum tolerance limit permitted by the specifications.
TL is the lower or minimum tolerance limit permitted by the specifications.
F is the price reduction factor to be applied for each element as shown in Table 105-2 and Table 701-15E.

Table 701-15 E
Grade S Volumetric
TABLE OF PAY FACTORS

Incentive Item	"F" Factor	Maximum Pay Factor
Voids in Mineral Aggregate (VMA)	6	1.02
Voids Filled with Asphalt (VFA)	2	1.02
Voids in Total Mix (VTM)	6	1.02
Dust/ asphalt ratio (D/A)	30	1.02

If P is less than 3 or a negative value, the lot will be accepted as being in conformance. If one or more elements for a contract item show a positive P value, the positive values will be added and the resulting sum used to determine whether the lot is in conformance. If the total P value is between 3 and 25, the Engineer may require correction or accept the lot at a reduced price. If P is greater than 25, and three tests within one lot have one or more elements outside the established job mix target range the Engineer may: (1) require complete removal and replacement with specification material at Contractor expense; (2) require corrective action to bring the material into conformance at Contractor expense; (3) where the finished product is capable of initially performing the intended purpose but with a reduced service life expectancy, permit leaving the material in place with an appropriate price adjustment calculated using a P value ranging between 25 and 50; or, (4) allow production to continue if revised (final) targets have not been set.

Immediately halt production when directed by the Project Manager when either of the following has occurred:

(1) Three consecutive lots for a contract item have an individual total P value of 5 or more;

(2) When three tests within one lot have one or more elements outside the established job mix target range (as outlined in 710-15 D) and the calculated P value at that time is 5 or more.

Make adjustments to bring the material within the specification limits before resuming production. The Contractor does not have the option of accepting a price reduction in lieu of producing material meeting specifications. Do not continue production of non-specification material. Material that is obviously defective may be isolated and rejected without regard to sampling sequence or location within a lot.

The Project Manager may allow the adjustments to be made without halting production.

When adjustments are being made for one of the two reasons above, the Department may require additional samples to test the material being produced, in addition to the planned random samples. These additional tests will be used to determine if the adjustments are effective and production may continue. These tests are not part of Quality Assurance under 105.03.2

Delete Subsection 1.C.4 and substitute the following:

3) Total Project Payment. The total project payment for HMA pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons of HMA mixture used in the accepted work. Payment in excess of 100 percent for accepted lots of HMA pavement shall be used to offset payment for accepted lots of HMA pavement that achieve a lot

pay factor less than 100 percent. The calculation of excess and offset shall be applied as equivalent amounts. In the event a lot is identified for removal and replacement in accordance with criteria specified in the SSHP specifications, or as specified in other sections referenced in the SSSM, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and the Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price AND THE TOTAL PROJECT PAYMENT LIMITATION SHALL BE REDUCED BY THE AMOUNT WITHHELD FOR THE REJECTED LOT.

Outlier Determination and Payment Adjustment for Volumetric Properties Only. If suspect test values are noted during construction, the Department will check plant production information, test equipment, processes, calculations, etc. for errors. If a problem is noted in the plant production, sampling or other process controlled by the Contractor, the test result will be considered valid until production is complete. If a problem is found with the testing or other Department process, the test result will be corrected or the test redone on material from the same sample, if possible. If a non-correctable testing problem is found, the result will be discarded, if possible another sample will be taken and the new result used in its place. If re-sampling is not possible, the Department may discard the test results for a sub-lot considered to be an outlier and recalculate the incentives and disincentives using the remaining results in the lot. The Department may follow standard QA guidelines to adjust lot sizes.

If no identifiable problem is found, no corrections will be made until production is complete.

The following outlier evaluation only applies to projects with 10 or more QA sub-lots.

After all production of this product is completed, the Department will determine the Standard Deviation and Mean of all the Department's test results for each volumetric property representing material produced after the initial targets were set. For each volumetric property test, the Z value is defined as the absolute value of the difference between the test value and the Mean, divided by the Standard Deviation. If the average of the Z values of the four volumetric properties in a sub-lot is greater than 2.00, the Department may consider the sub-lot an outlier. If more than one sub-lot outlier is identified in a lot, the test results will not be considered outliers. The Department will not adjust for outliers within the last lot of production.

The Department will discard the test results for a sub-lot considered to be an outlier and recalculate the incentives and disincentives using the remaining results in the lots. The Department will follow standard QA guidelines to adjust lot sizes.

4) Composition of Mixtures.

a) Job Mix Formula. Establish a target asphalt binder content. Base the target asphalt binder content on design and field gyratory mix test results. Mix Design Bulk Dry Aggregate Specific Gravities will be used during plant mix production unless otherwise directed by the Project Manager.

b) Plant Mix Sampling and Acceptance. Furnish the Project Manager a 45 lb (20 kilograms), or larger sample as directed, of plant mix surfacing material. The Project Manager will randomly select when plant mix samples are taken. Follow Sampling Procedure MT-303. A Department inspector will witness plant mix sampling. Furnish the sample to the inspector immediately after it is taken if requested or deliver the sample to the Departments designated test location after the inspector seals the sample in a tamper proof container. Plant mix sampling will be delayed until after the initial daily 100 tons (100 metric tons) of plant mix has been produced or when a hot plant is cleaned out (clean out) and 100 tons (100 metric tons) of plant mix has been produced. No sampling delay will be permitted at any other time, unless approved by the Project Manager.

5) Equipment.

a) Mixing Plants. Use mixing plants that produce a mix meeting the contract requirements.

b) Weigh System.

(1) Automatic Weighing. Use state certified automatic weigh systems to weigh materials. Ensure the weigh accuracy is within plus or minus 0.5 percent of the true weight throughout the use range.

Include in the system an automatic printer that provides the following information:

(a) Project No. (as shown on plans)
(b) Item Name (as shown on detail estimate)
(c) Date
(d) Time
(e) Ticket Number (consecutive)
(f) Haul Unit No.
(g) Net tons (metric ton) in load (to nearest 0.05 ton)
(h) A subtotal of tons (metric tons) for each haul unit since the beginning of the shift.
(i) An accumulated total for all haul units since the beginning of the shift.

Use a pre-programmed printer or one equipped to prevent manual override of any weight information. Have the weigh system tested, certified, and sealed by the State Bureau of Weights and Measures after each plant move and before production for a project. Immediately stop production should the printer malfunction or breakdown and do not resume until corrected. Delivery of material from storage or surge bins will be permitted only if the weight can be maintained within weigh specifications.

If an independent certified scale is within a 20 mile (32 km) round trip distance from either end of the project, the Project Manager will randomly designate the re-weighing of loaded vehicles, at least three times per project.

Re-test the plant weigh system any time the difference between the re-check and the plant system exceeds plus or minus one half of one percent of the load. Any weight difference will be addressed under Subsection 109.01.1.

(2) Manual Weighing. The Contractor may manually weigh and record weights instead of using an automatic weigh system. Ensure manual weighing includes platform scales meeting Subsection 301.03.2(C), a competent weigh person, and dump person.

Direct the weigh person to record, on Department furnished forms, weights to the nearest 100 pounds (45.4 kilograms) as well as the other required information regarding delivery and placement.

Tabulate and furnish a machine tape for the total of the weighed material delivered and placed on the roadway each shift. Certify that weights and totals furnished are a true and correct record of materials delivered and placed in the work. Deliver the records and totals to the Project Manager before 10:00 a.m. the next work day following the shift.

6) Safety Requirements. Install and maintain stairs, ladders, walkways, and all other plant facilities meeting State and Federal safety requirements.

Provide access to the tops of truck bodies for taking samples and mix temperature data.

7) Burner Fuel Restrictions. Use one of the approved fuels below to heat and dry aggregates.

a) Propane
b) Butane
c) Natural Gas
d) Fuel Oil (grades 1 and 2 only)
e) Coal

EPA Specification-Used Oil Fuel (EPA-UOF) may be used instead of the approved burner fuels provided the following requirements are met.

Physical Properties	Property Range
API Gravity	20-28
Viscosity at 12˚F (6˚C) (Saybolt Flurol)	10-20
Pour Point ˚F ˚C	+10 (-12)
Flash Point, min. Point ˚F ˚C	100 (37.8)
Water by Distillation %	Under 1
Solids by Separation %	Under 1
Ash %	Under 0.4
Sulfur	Average 0.5%
Kinematic Viscosity at 10˚F (37˚C) (centistokes)	54-100
Kinematic Viscosity at 12˚F (60˚C) (centistokes)	15-75

Chemical Properties

Element or Compound	Permitted Level
Vanadium	Under 100 ppm (100 mg/L)
Cadmium	Under 2 ppm (2 mg/L)
Chromium	Under 10 ppm (10 mg/L)
Lead	Under 100 ppm (100 mg/L)
Arsenic	Under 5 ppm (5 mg/L)
Total Halogens	Under 1,000 ppm (1,000 mg/L)
PCB's	Under 2 ppm (2 mg/L)

Furnish a copy of certified test results from the supplier for each load of EPA-UOF delivered to the project. Also furnish plant manufacturer information showing the plant burner is designed and equipped to burn EPA-UOF. Upon request, provide a one-quart (liter) sample of EPA-UOF from the tank on the project

Immediately stop using EPA-UOF fuel if burner flame outs or other evidence of incomplete combustion or mix contamination is evident. Begin using one of the other approved fuels to complete the work. Remove and replace all contaminated plant mix at contractor expense. No additional compensation will be allowed.

8) Hydrated Lime or Mineral Filler Feed System. Introduce the dry hydrated lime and mineral filler into drum dryer mixing plants just below the asphalt binder introduction point.

Use alternate lime introduction methods only with the Project Manager's written approval.

Ensure the system provides positive, accurate material feed and is automatically synchronized to the aggregate feed. Ensure the system indicates the weight entering the mixing unit on a time-coordinated basis.

Weigh using an automatic indicating electronic system. The lime or mineral filler may be weighed directly, or the storage container including lime or mineral filler may be weighed.

Provide a continuous digital readout showing the weight or rate of feed in tons (metric tons) per hour. Record the information using a production monitor/recorder system or by a de-cumulating balance ticket printing system. Record the information at minimum five-minute intervals or as directed.

Silo or storage container system weights are not used for acceptance during filling or transfer. Limit filling or transfer periods to one hour per three hours of plant operation. Record and furnish start and finish times for filling or transfer and the total quantity added.

Suspend mixing for erratic feeding or failure to feed hydrated lime or mineral filler to a minimum of 85% of the job mix formula. Do not resume until corrected or repaired.

9) Flow Rate Meter. Measure the asphalt binder discharged into the mixing unit using a flow rate meter with totalizer and temperature compensation.

Ensure the totalizer records up to 1,000,000 gallons (3,785,000 L) and is certified to plus or minus 0.20 percent of the measured quantity.

Use a flow rate meter and totalizer that automatically corrects to a temperature of 60˚F (16˚C) with an operating range of +60˚F (16˚C) to +450˚F (232˚C).

Locate the totalizer readout in the plant control room so it is readily accessible to the inspector.

Ensure the flow rate meter automatically shuts off any time asphalt binder is diverted or stops entering the mixing unit.

Calibrate the flow rate meter and totalizer before the start of the project and as necessary during production. The Project Manager will witness the calibration.

Provide the equipment and assistance for initial and subsequent calibration checks and furnish the Project Manager a copy of all calibration checks.

Use a calibration volume of at least 3,000 gallons (11,355 L). Ensure the weigh scales have been tested and certified.

Furnish the Project Manager one copy of a test report showing the asphalt binder specific gravity.

Spot check failure will require re-testing and certification of the above. The Project Manager will establish the spot check interval.

10) Production Monitor-Recorder. Use recording equipment that automatically monitors and records on a time coordinated basis, the aggregate, lime, mineral filler, and asphalt binder weight entering the mixing unit. The records may be continuous (chart recorder) or digital printout.

Ensure that chart recorders clearly record asphalt binder content changes of 0.1 percent or more and aggregate feed rate changes of 1.5 percent or more.

Ensure the digital printout equipment records the day's total production at minimum five-minute intervals, or the interval directed by the Project Manager.

Digitally display the aggregate and asphalt binder rates in tons (metric tons) per hour and daily totals. Display lime or mineral filler by tons (metric tons) per hour or on a de-cumulating balance.

Ensure the monitor system operates on unprocessed signals from measuring devices.

Provide the Project Manager continuous access to the recorder during production.

Submit the permanent record to the Project Manager daily.

Operate the production/monitor recorder at all times during production. Stop production when the recorder is not operational.

11) Asphalt Binder Mixture Preparation.

All Plants.

Mix the aggregate and asphalt binder to produce a homogeneous mixture. Ensure all aggregates are thoroughly and uniformly coated with bitumen.

Remove, dispose of, and replace all mix that is damaged by burning, improper mixing, or fails to meet the specifications at Contractor expense.

Maintain the mix discharge temperature within the asphalt binder manufacturer's recommended mix temperature range.

The discharge temperature will be periodically checked and recorded.

Ensure the average of any three checks is within the specified limits.

Suspend plant operations when the mix discharge temperature is outside the range.

12) Roadway Equipment.

a) Pavers. Use self propelled pavers that spread, shape, and finish the combined plant mix material to the specified profile and cross slope.

Immediately stop paving if the paver tears, shoves, segregates or otherwise damages the plant mix, and repair or replace the paver before resuming paving operations.

Equip the paver with a mobile grade reference system that provides a uniform pavement profile. Ensure the paver maintains the transverse slope at all times and is able to adjust the slope throughout super-elevated curves.

Ensure auger extensions are used to match the screed width.

Equip the paver with an attachment that produces joints meeting requirement 18 below as the surfacing course is placed.

b) Trucks. Remove trucks from service that leak fluids. When directed, cover each load with canvas or other approved material to protect the mix at Contractor expense.

c) Rollers. Furnish and use rollers that compact the plant mix to the specified density. Remove rollers that crush the paving aggregates or otherwise damage the plant mix and replace the damaged plant mix at contractor expense.

d) Cleaning Agents. Do not use diesel fuel as a cleaning agent or as a release agent for any paving equipment or operations. Use a commercially manufactured release agent approved by the Project Manager

13) Existing Surface Preparation. Perform existing surface preparation meeting Section 204 requirements.

14) Aggregate Treatment and Tack Coat. Apply aggregate treatment and tack coat meeting the applicable requirements of Sections 407 and 410 and the Contract.

Apply aggregate treatment as directed before placing the plant mix.

Allow the aggregate treatment to cure at least 24 hours before placing the plant mix unless otherwise approved.

Apply tack coat on existing surfacing to be overlaid and between lifts when pavement is constructed in multiple lifts.

Delete Subsection 1.C.16 and substitute the following:

15) Surface Conditions, Weather Limitations, and Paving Dates. Stop plant mix paving when the surface temperature is less than 35˚F (2˚C); the surface is wet; the roadbed is unstable or the Project Manager determines adverse weather conditions prevent the proper handling, finishing, or compacting of the mix.

Complete all sections of plant mix pavement, to be open to traffic during winter suspension, to the full plan width and thickness, excluding seal coat. Complete this work meeting the specifications before the November 1st paving cessation date.

The Project Manager will suspend time assessment between November 1st and November 16th when the next scheduled significant work item is paving and all grading, gravel and other operations affecting the safe and convenient use of the roadway by the traveling public are complete.

Submit a written request to the Project Manager and obtain written approval in order to pave after November 1st. and before April .

Plant mix surfacing placed after November 1st and before April 15th is at the Contractor's risk and subject to the following conditions.

- The surface temperature to be paved is at least 35˚F (2˚C), measured by the Project Manager.

- All applicable specifications are met.

Make permanent repairs and restore partially completed pavement to the required profile, section, and condition at Contractor expense before placing the remaining lifts.

This is not a waiver by the Department of any other contract requirement regarding the work sequence or traffic operation.

If the paving operation causes transverse joints spaced at less than one half mile (805 m), suspend work until the next April 15th.

No payment is made for the plant mix or asphalt on progress estimates between November 1st and April 15th for partial width or thickness.

Promptly repair damage to all partial width or thickness of plant mix surfacing used by traffic during this period for any reason including suspension of work due to adverse weather.

Provide all required interim traffic striping and traffic control on partially completed pavement at Contractor expense.

Failure to promptly make repairs and provide interim striping and traffic control is cause for the Department to perform or have the work performed and deduct the cost from monies due or that may become due the Contractor.

Payment for partial width or thickness pavement in acceptable condition will be made on the estimates following the end of the period on the next April 15th.

Delete Subsection 1.C.17 and substitute the following:

16) Spreading and Finishing. Place and spread the mix to the widest practical width on the approved surface. Place shoulder-widening material with approved equipment.

Establish and maintain line control for paving. The Project Manager will furnish the contractor the necessary information to establish these controls. Maintain the paving control line tolerance within 0.25 foot (75 millimeters) of a true line from the existing reference points.

Failure to maintain the paver control line within the specified tolerance is cause for corrective action or pavement removal and replacement, as directed by the Project Manager, at contractor expense.

Include the cost of furnishing horizontal line control in the plant mix pavement bid item.

Remove and replace segregated pavement areas behind the paver with new plant mix before initial rolling begins. Correct all segregated areas at Contractor expense.

On small or irregular areas, approaches, turnouts, around manholes, inlets, walls, and on other areas not readily accessible to a paver, plant mix may be spread to the specified thickness using a specialty paver or other approved methods. Compact these areas as directed.

Place the plant mix at all areas not covered under the ride specification meeting the surface tolerances meeting section 23 below.

Remove and replace all plant mix that is segregated, loose, broken, contaminated, damaged, or otherwise defective, with new plant mix that meets contract requirements at Contractor expense.

Delete Subsection 1.C.18 and substitute the following:

17) Constructing Joints. Continuously place each lift and provide at least a 6-inch (150 mm) offset between longitudinal joints in successive lifts. Offset transverse joints in successive lifts by at least six feet (1.8 m).

Correct joints which do not meet the surface tolerance requirements in Section 23 of this provision.

Uniformly coat the exposed face of all joints, excluding those formed by echelon paving, with SS-1 emulsified asphalt or other approved asphalt just before placing the abutting course.

Construct longitudinal joints in the top lift of plant mix outside the wheel paths to the extent practical.

Construct a vertical transverse joint the full lift depth if the mix cools below the low temperature of the compaction temperature range recommended by the asphalt binder manufacture. Remove loose material, brush the joint face with asphalt, and compact the fresh mix against the joint face when paving is resumed.

Taper the longitudinal paving joint edges at a 4:1 to 6:1 slope. Compact the joint between abutting passes to the specified plant mix density.

Construct the joints at rigid structures after the existing base is prepared and compacted. Apply a coat of SS-1 emulsified asphalt to the portions of structures abutting the plant mix pavement.

Delete Subsection 1.C.19 and substitute the following:

18) Compaction, Compaction Control Testing, and Density Acceptance Testing.

a) Compaction. Complete compaction rolling within the temperature range recommended by the asphalt binder supplier included in the mix design.

b) Compaction Control Testing. Perform all necessary density testing to control compaction.

Once the plant mix is spread, struck off, and surface irregularities are corrected, compact the plant mix to at least 94% of the field established Maximum Specific Gravity.

c) Leveling, Patching, and Thin Lifts. Density acceptance by Cores does not apply to initial plant mix lifts used for leveling ruts, sags, or other existing surface defects that are less than 0.10 foot (30 mm) thick.

19) Density Acceptance by Cores.

Provide core samples of the compacted plant mix from the roadway. Core locations will be randomly selected based on the tons (metric tons) of mix placed. Core the locations selected after all rolling is complete and before the roadway is opened to traffic. Areas within 1 foot (300 mm) of a free edge, or where the planned nominal thickness is less than 0.10 foot (30mm), are excluded from testing. The pavement density is determined from cores taken at randomly selected locations after all rolling is complete and before the roadway is open to traffic.

Perform the following work within the project site:

- Take cores after all rolling is complete
- Core two 4 inch (100 mm) or two 6 inch (150 mm) cores the full depth of the plant mix surfacing, extracted from within a 7.5 inch (190 mm) radius of each designated location. Mark the core as directed.
- Separate the plant mix lift to be tested from the total core. Cut the core to the actual lift thickness within plus or minus 0.15 inch (4 mm). The Department recommends using a saw to separate the lift to be tested from the total core. Perform this work within the project limits or other approved location.

The inspector will witness all of the above activities before traffic is permitted to use the plant mix lift being tested.

Furnish the core immediately to the inspector after it is removed, marked and separated. Do not remove the cores from the Inspector’s visual control at any time. Recore as directed any time either the Contractor requirements or procedures of this provision (as outlined under part C 20) Density Acceptance by Cores are not met. The test results of the replacement core to be used in the QA evaluation for the lot represented will be the actual relative in-place density unless it exceeds 92%. If the actual in-place density of the replacement core is greater than 92%, then 92% will be used for the relative in-place density of that core in the QA evaluation.

The plant mix in the sub lot represented is considered to be not meeting density specifications.

Remove free water from each core hole, place and compact new plant mix (or approved cold patch mix) not exceeding 2 inch (50 mm) lifts to the finished surface immediately after the core is removed. Mark each core as directed by the inspector witnessing the coring.

MT 328 is used to establish the target Rice density. The Bulk Specific Gravity (MT-314) determined for each core will be divided by the target Rice density in effect at the time the plant mix was produced to determine the relative in-place density.

The approximate mix quantity represented by each sub-lot is 600 tons (600 metric tons). Additional locations and tests may be required. The quantity represented by 5 tests or approximately 3000 tons (3000 metric tons) of mix constitutes a lot whenever production schedules and material continuity permit. A lot represented by 3 to 7 consecutive random sub-lots will be established when there are short production runs, significant material changes, or other unusual characteristics of the work.

All costs of furnishing the cores will be considered incidental to Plant Mix Bituminous Surfacing items and no separate measurement or payment will be made.

Delete Subsection 1.C.21.

Delete Subsection 1.C.22 and substitute the following:

20) Pavement Repair. Cut out the defective pavement to at least one-inch (25 mm) depth. Clean the sides and bottom of the hole and apply approved asphalt to the surfaces. Fill the hole with fresh mix, level, and compact to the specified density and surface smoothness. Skin patching shall not be permitted. High points may be grounded off.

Delete Subsection 1.C.23 and substitute the following:

Surface Tolerances. The final surface shall be free from roller marks. The finished surfaces of each course of the pavement, except the finished surface of the final course, shall not vary more than ⅜ inch when evaluated with a 16 foot straightedge. The finished surface of the final course of pavement shall not vary more than ¼ inch when evaluated with a 16 foot straightedge. The lot size shall be 2,000 square yards. Smoothness measurements shall be made at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made at the center of each paving lane. In the transverse direction, smoothness readings shall be made continuously across the full width of the pavement. However, transverse smoothness readings shall not be made across designed grade changes. At warped transition areas, straightedge position shall be adjusted to measure surface smoothness and not design grade transitions. When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above

Delete Subsection 1.C.24 and substitute the following.

Grade: The finished surface of the pavement shall not vary from the grade line elevations and cross sections shown on the plans by more than ½ inch (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet) to determine the elevation of the completed pavement. The Contractor shall pay the cost of surveying of the level runs that shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer. The lot size shall be 2,000 square yards (square meters). When more than 15 percent of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates ¾ inch or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. The surface of the ground pavement shall have a texture consisting of grooves between 0.090 and 0.130 inches wide. The peaks and ridges shall be approximately 1/32 inch higher than the bottom of the grooves. The pavement shall be left in a clean condition. The removal of all of the slurry resulting form the grinding operation shall be continuous The grinding operation should be controlled so the residue from the operation does not flow across other lanes of pavement. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above

21) Skid Resistance and Surface/Saw-Cut Grooves: If shown on the plans, skid resistant surfaces for HMA pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving. Transverse grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1-1/2 center to center configuration. The grooves shall be continuous for the entire length of the grove. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for saw-cut groves shall meet the following:

- **Alignment tolerance** – Plus or minus 1-1/2inches in alignment for 75 feet.
- **Groove tolerance** – Minimum depth of 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch. Maximum depth 5/16 inch. Minimum width ¼ inches. Maximum width 5/16 inch.
- **Center-to-center spacing** – Minimum spacing 1-3/8 inches. Maximum spacing 1-5/8 inches.

Grooves shall not be less than 6.0 inches and not more than 18.0 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with governing laws and regulations. All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

E. Method of Measurement

1) Plant Mix Pavement. Plant mix pavement is measured by the ton (metric ton) on approved scales after complete mixing of all ingredients. The pay weight includes the asphalt binder and mineral filler or hydrated lime in the mixture.

2) Asphalt Binder. Asphalt Binder is measured by the U.S. gallon (Liter) or the ton (metric ton) as specified to the nearest whole gallon (liter) or ton (metric ton), under Subsection 402.04, excluding anti-stripping additive.

3) Hydrated Lime. Hydrated lime is measured by the ton (metric ton) meeting Subsection 109.01. Hydrated lime exceeding 1.6 percent by total weight of mix is not measured for payment as hydrated lime.

Delete Subsection 1.D.4.

4) Tack Coat. Tack coat is incidental to the plant mix surfacing and is not measured for payment.

Delete Subsection 1.E and substitute the following:

F. Basis of Payment. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Plant Mix Pavement	Ton (metric ton)
Asphalt Binder	Gallon (liter) or Ton (metric ton)
Hydrated Lime	Ton (metric ton)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

APPENDIX G2

MTDOT

Special Provision 401-1a
Plant Mix Bituminous Surfacing
Grade S Volumetric Acceptance

<u>401-1a Plant Mix Bituminous Surfacing – Grade S Volumetric Acceptance (Revised 12-19-07)</u>
(Change 3rd sentence to ½ inch (12.5 mm) if needed)

1. <u>PLANT MIX BITUMINOUS SURFACING - GRADE S VOLUMETRIC ACCEPTANCE [401] (Revised 12-19-07)</u>

A. Description. This work is producing, furnishing, placing, and compacting hot mix asphalt pavement. This specification covers ¾ inch (19 mm) and 1/2inch (12.5 mm) nominal aggregate size, Grade S plant mix. Provide Grade S plant mix meeting all requirements for the ¾ inch (19 mm) nominal aggregate size.

Standard Specifications Sections 401 and 105.03.3 are rescinded. Standard Specification 105.03.2 is rescinded for Cold Feed Aggregate Gradations only.

B. Materials. Furnish aggregate from sources meeting the applicable Section 106 requirements.

Submit four copies of a written Quality Control (QC) Plan to the Project Manager for plant mix aggregate, and plant mix surfacing, before production of each material. It is recommended that the contractor use generally recognized Statistical Quality Control methods and tests. Be responsible for all sampling, testing and control of the aggregate. Furnish the Project Manager four copies of the quality control test results upon request.

Ensure that the aggregate, when combined at the job mix formula, meets Table 701-15B, and applicable subsection 701.03.1 requirements.

It is recommended that at least three separate aggregate stockpiles be produced.

1) Aggregate Requirements. Meet the following aggregate requirements at the job mix formula combined ratio:

<u>Coarse Aggregate (No. 4 (4.75 mm) and larger)</u>

Angularity (MT-217 or ASTM D-5821)	See Table 701-15B
Wear (MT-209 or AASHTO T-96)	40% max.
Flat and Elongated Particles (ASTM D-4791)	
(3:1 Ratio; by mass; <u>No. 4 (4.75 mm)</u> and larger)	20% max.

<u>Fine Aggregate (No. 8 (2.36 mm) and smaller)</u>

Angularity (AASHTO T-304 Method A)	45% min.
Sand Equivalent (MT-213 or AASHTO T-176)	45% min.
If aggregate cannot meet the Sand Equivalent, meet the following:	
Volume Swell, untreated aggregates (MT-305)	10% max.
Aggregate must be non-plastic (MT-208 or AASHTO T-89 & T-90)	

2) Hydrated Lime. Furnish hydrated lime meeting subsection 713.02. Include 1.4% hydrated lime by total weight of mix as part of the aggregate gradation.

3) Asphalt Binder. Furnish performance grade asphalt binder meeting Section 702, Table 702-9 and the grade specified in the contract.

4) RAP – Recycled Asphalt Pavement. RAP may be incorporated into the mix. If RAP is included in the job mix formula and the final mix, meet all the Volumetric Grade S requirements in this special provision. Aggregate and asphalt binder requirements 1.B.1 and 1.B.3 apply to virgin materials only. It is recommended that at least two separate RAP stockpiles be produced.

5) Mix Design and Materials Samples. Submit to the Project Manager four copies of a Superpave volumetric mix design following AASHTO R35 and meeting AASHTO M323, as modified in these provisions. Include the binder supplier's recommended mixing and compaction temperature ranges. Choose the Design Air Voids target to be the lowest value, within the range of 3.4 and 4.0, such that all other volumetric criteria are met. Report the dust/asphalt (D/A) ratio for the target asphalt content. The mix design is to be produced on a total weight of mix basis. On contracts with multiple gravel sources, or combination of gravel sources, provide a mix design and meet all the requirements in this provision for each source or combination of sources and suppliers. For mix designs using RAP, furnish the RAP asphalt content and the virgin asphalt content and the RAP gradation and the virgin aggregate gradation. Also supply all specific gravities. Furnish quantities from each stockpile to produce an 800-pound (363 kg) sample, when combined at the mix design blend ratio and 5 gallons (19 L) of the PGAB. The Department has thirty calendar days from receipt of the mix design materials and signed mix design documents to review the mix design. Do not begin plant mix production until receiving notification that the Departments mix design verification is complete. The mix design verification consists of passing Hamburg Wheel Track test results and a review of the submitted mix design documents to ensure all applicable design requirements have been met. Contract time will be extended; day for day without any other compensation for Department caused delays beyond the allowed thirty calendar days from receipt of the mix design materials, if the delay affects the start of paving as shown on the contractors work schedules. Contract time will not be extended if the delay occurs between November 1 and April 15.

6) The Department will perform the Hamburg Wheel Track testing and use the test results to verify the plant mix design.

7) Meet the design requirements in Table 701-15B, Table 701-15B (1), and the Hamburg Wheel Track requirements in Table 701-15 C.

Table 701-15 B

¾ inch (19 mm) and 1/2inch (12.5 mm) Nominal Maximum Aggregate Size)
SUPERPAVE VOLUMETRIC MIXTURE DESIGN REQUIREMENTS

[1]20 Year Design ESALs		Number of Compactive Gyrations			Percent of Rice			Course Aggregate Angularity 1 face/ 2 face	VMA %		VFA %	VTM % (Air Voids)	[2] (DP) Dust to effective binder ratio
Total (million)	Daily	Initial (N_{ini})	Design (N_{des})	Max. (N_{max})	Max @ N_{ini}	@ N_{des}	Max @ N_{max}		At N_{des} (Minimum)		At N_{des} Range	At N_{des} Range	(P0.075/Pbe) Range
									19.0 mm	12.5 mm			
< 0.3	<41	7	75	115	91.5	96-96.6	98	75/ -	≥13.0	≥13.5	70 to 80	3.4 to 4.0	0.6 to 1.6
0.3 to < 3	41- 410	7	75	115	90.5	96-96.6	98	85/80	≥13.0	≥13.5	65 to 78	3.4 to 4.0	0.6 to 1.6
3 to < 10	410-1370	8	100	160	89	96-96.6	98	85/80	≥13.0	≥13.5	65 to 78	3.4 to 4.0	0.6 to 1.6
≥ 10	≥ 1370	8	100	160	89	96-96.6	98	95/90	≥13.0	≥13.5	65 to 78	3.4 to 4.0	0.6 to 1.6

[1] If ESAL's are not specified in the contract, use the 3-10 million ESAL design requirements in table 701-15 B to develop the mix design, unless otherwise directed by the Project Manager.

[2] In addition to meeting the DP requirement at mix design, report the dust/asphalt ratio (D/A) on the mix design.

Table 701-15 B (1)

AGGREGATE DESIGN REQUIREMENTS ¾ inch (19 mm) and 1/2inch (12.5 mm) Nominal Maximum Aggregate Size)							
Percent by Weight Passing Square Mesh Sieves							
	Gradation Limits					[1]Primary Control Sieve (PCS)	
	¾ in (19.0 mm)		½ in (12.5 mm)			¾ in (19.0 mm)	½ in (12.5 mm)
Sieve	Min	Max	Min	Max		PCS	PCS
1 inch (25 mm)	100						
¾ inch (19 mm)	90	100	100				
½ in (12.5 mm)		90	90	100			
3/8 in (9.5 mm)				90			
4 M (4.75 mm)						47	
8 M (2.36 mm)	23	49	28	58			39
16 M (1.18 mm)							
30 M (0.600 mm)							
50 M (0.300 mm)							
100M (0.150 mm)							
200 M (0.075 mm)	2	8	2	10			

[1]The combined aggregate gradation is classified as coarse graded when it passes below the Primary Control Sieve (PCS) control point. All other gradations are classified as fine graded.

Use MT 330 to determine the mixture resistance to moisture induced damage, modified as follows:

Compact the 6-inch (150 mm) diameter specimens to 3.75 in. ± 0.20 (95 mm ± 5 mm), at 7 ± 1.0 percent air voids. Meet a tensile strength ratio of 0.7 or greater.

Table 701-15 C
HAMBURG WHEEL TRACK GRADE "S" SPECIFICATIONS
AT 122° F (50° C)

PG Binder Grade	Not To Exceed 0.5" (13 mm) Rut in Number of Passes	
	Produced Plant Mix	Mix Design
PG 58-28 and PG 64-22 and PG 64-28	10,000 Passes	15,000 Passes
PG 64-34 and PG 70-28	15,000 Passes	20,000 Passes

C. Construction Requirements. Produce plant mix meeting Table 701-15 B, Table 701-15 B (1) Table 701-15 C, 701-15 D form CB30-QA-VM (S) and the following targets:

701-15 D
GRADE "S" VOLUMETRIC SPECIFICATIONS
¾ inch (19 mm) and 1/2inch (12.5 mm) Nominal Maximum Aggregate Size

Volumetric Property	Job Mix Target Limits		Job Mix Tolerance	Start-up Job Mix Range ***	
Voids in Mineral Aggregate (VMA)	¾ inch (19 mm)	1/2inch (12.5 mm)	± 0.6	¾ inch (19 mm)	1/2inch (12.5 mm)
	13.0 to 17.0	13.5 to 18.0		12.4 to 17.6	12.9 to 18.6
Voids Filled with Asphalt (VFA)	65 to 80		± 5.0	60 to 85	
Voids in Total Mix @ Ndes. (VTM)*	3.4 to 4.0		± 1	2.4 to 5.0	
Dust/Asphalt Ratio (D/A)**	N/A		±0.2	N/A	

* Choose the Design Air Voids target to be the lowest value, within the range in the table above inclusive of 3.4 and 4.0, such that all other volumetric criteria are met.

** Percentages or Quantities of hydrated lime will not be subtracted from the aggregate gradation.

***Start-up job mix range only applies to production before initial target set. Tolerances do not apply to start up job mix range.

Do not begin plant mix paving operations until two working days after the test trailer is made fully operational, (blocked, powered, and acceptable to the Engineer), unless authorized by the Engineer.

Set the initial volumetric job mix targets before producing more than 3000 tons of Plant Mix Surfacing. Plant Mix produced prior to setting initial targets is defined as start-up mix. Furnish the Project Manager four signed copies of form CB30-QA-VM (S) with the proposed job mix targets for Voids in the Mineral Aggregate (VMA), Voids Filled with Asphalt (VFA), Voids in Total Mix (VTM), and Dust to Asphalt Binder Ratio (D/A). Once the job mix targets are set, Quality Assurance (QA) will be applied to all subsequent Grade S material produced. No volumetric pay incentive or disincentive will be applied to the plant mix until the volumetric targets are set. Produce start-up mix meeting the criteria listed under the Start-Up Job Mix Range in table 701-15 D. A Hamburg test will be run when the produced mix does not meet all the criteria specified under the Start-Up Job Mix Range in table 701-15 D.

The contractor may revise the volumetric job mix targets one time during the contract. Submit revised job mix targets no later than 2 days following completion of plant mix production, or initial job mix targets will be used to determine payment. If more than one project is included in the contract (tied projects), the volumetric job mix targets may be revised for each project only if the projects use different mix designs. Submit to the Project Manager four signed copies of form CB30-QA-VM (S) with the revised job mix targets for VMA, VFA, VTM, and D/A. The revised targets will be applied retroactively to all plant mix produced after the initial targets are set, and payment will be recalculated.

No monetary, time or other compensation will be allowed for Department actions required due to the initial targets, (i.e. P-value shutdowns, etc.).

A change in the asphalt supplier or aggregate source(s) will not require a new mix design, provided no change in the established volumetric job mix targets is requested, and the aggregate requirements, and Hamburg Wheel Tracking requirements are met. Provide the apparent and bulk dry specific gravities, and absorption for the aggregate, and the specific gravity for asphalt binder when there are changes in the source(s).

1) Hamburg Wheel Tracking. The Department may require Hamburg samples at any time, including the production of start-up mix. Provide the Project Manager a sample of plant mix surfacing material for Hamburg Wheel Track acceptance after initial job mix targets have been established. Provide additional samples as directed.

Remove and replace any start-up plant mix represented by a failing Hamburg test at no cost to the Department.

Make adjustments to produce plant mix meeting the requirements if a sample taken after initial targets have been set does not meet the Hamburg Wheel Track requirement specified in the contract,.

When two consecutive Hamburg samples do not meet the requirements, suspend production and submit a revised mix design and samples for verification and Hamburg Wheel Track testing The initial Mix Design requirements will be used for verification. Do not resume production until the revised mix design is verified and Hamburg Wheel Track mix design requirements are met.

Plant mix lots represented by samples that do not meet Hamburg Wheel Track specifications are not eligible for QA incentives including ride and density incentives.

2) Test Procedures. Plant mix will be evaluated using the following test procedures.

MT-303 - Sampling Bituminous Materials

MT 332 – Gyratory Compaction of Bituminous Mixtures

MT 321 – Maximum Specific Gravity of Bituminous Mixtures (Rice Method)

MT-319 – Ignition Oven Burn Procedure

MT 320 – Gradation of Aggregate Recovered by MT 319 Ignition Oven Burn Procedure

MT 330 – Resistance of Bituminous Mixture to Moisture Induced Damage

MT 334 – Wheel Tracking Test Procedure (Hamburg Device)

3) Items Designated for Acceptance on A Lot Basis (Quality Assurance or QA). The volumetric properties listed in Volumetric Grade S Table 701-15 D are designated for acceptance on a lot-by-lot basis. The elements in the Table 701-15D are evaluated and the contract items accepted under this specification. The pay factor in Volumetric Grade S Table 701-15E is applied to plant mix surfacing lots for Voids in the Mineral Aggregate (VMA), Voids Filled with Asphalt (VFA), Voids in Total Mix (VTM), and Dust Asphalt Ratio (D/A). The asphalt content used for volumetric calculations is determined using the asphalt ignition oven test method (MT 319). The Dust Asphalt Ratio (D/A) is calculated based upon test method (MT 319), and the gradation determined using the gradation method (MT 320) on the aggregate remaining after the ignition oven test.

The approximate mix quantity represented by each sub-lot is 1000 tons (1000 metric tons). The quantity represented by 5 tests or approximately 5000 tons (5,000 metric tons) of mix constitutes a lot whenever production schedules and material continuity permit. A lot represented by 3 to 7 consecutive random sub-lots will be established when there are short production runs, significant material changes, or other unusual characteristics of the work

No quality incentive allowance will be applied to plant mix aggregate gradation.

All other contract items are evaluated for acceptance under the applicable specifications covering those items.

Each element of a lot will be evaluated for pay adjustments.

All the individual test results in the lot for the element to be evaluated will be averaged, and the percent of price reduction for the lot determined by the applicable formula.

a) The formula P = (Xn + aR - Tu) x F will be used when the average of the test values is greater than or equal to the job mix target value.
b) The formula P = (TL + aR - Xn) x F will be used when the average of the test values is less than the job mix target value.

P is the percent of reduction in contract price.

Xn is the average of the several test values from samples taken from the lot, with n indicating the number of values.

a is a variable factor to be used as n changes according to the following: when n is 3, a = 0.45; n is 4, a = 0.38; n is 5, a = 0.33; n is 6, a = 0.30; and n is 7, a = 0.28.

R is the difference between the highest and lowest values in the group of test results from the lot.

Tu is the upper or maximum tolerance limit permitted by the specifications.

TL is the lower or minimum tolerance limit permitted by the specifications.

F is the price reduction factor to be applied for each element as shown in Table 105-2 and Table 701-15E.

Table 701-15E
Grade S Volumetric
TABLE OF PAY FACTORS

Incentive Item	“F" Factor	Maximum Pay Factor
Voids in Mineral Aggregate (VMA)	6	1.02
Voids Filled with Asphalt (VFA)	2	1.02
Voids in Total Mix (VTM)	6	1.02
Dust/ asphalt ratio (D/A)	30	1.02

If P is less than 3 or a negative value, the lot will be accepted as being in conformance. If one or more elements for a contract item show a positive P value, the positive values will be added and the resulting sum used to determine whether the lot is in conformance. If the total P value is between 3 and 25, the Engineer may require correction or accept the lot at a reduced price. If P is greater than 25, and three tests within one lot have one or more elements outside the established job mix target range the Engineer may: (1) require complete removal and replacement with specification material at Contractor expense; (2) require corrective action to bring the material into conformance at Contractor expense; (3) where the finished product is capable of initially performing the intended purpose but with a reduced service life expectancy, permit leaving the material in place with an appropriate price adjustment calculated using a P value ranging between 25 and 50; or, (4) allow production to continue if revised (final) targets have not been set.

Immediately halt production when directed by the Project Manager when either of the following has occurred:

(1) Three consecutive lots for a contract item have an individual total P value of 5 or more;

(2) When three tests within one lot have one or more elements outside the established job mix target range (as outlined in 710-15 D) and the calculated P value at that time is 5 or more.

Make adjustments to bring the material within the specification limits before resuming production. The Contractor does not have the option of accepting a price reduction in lieu of producing material meeting specifications. Do not continue production of non-specification material. Material that is obviously defective may be isolated and rejected without regard to sampling sequence or location within a lot.

The Project Manager may allow the adjustments to be made without halting production.

When adjustments are being made for one of the two reasons above, the Department may require additional samples to test the material being produced, in addition to the planned random samples. These additional tests will be used to determine if the adjustments are effective and production may continue. These tests are not part of Quality Assurance under 105.03.2

4) Quality Incentive Allowance. For each volumetric element with a ‘P’ value of less than three, the incentive is calculated by subtracting the calculated P value from three (3) to determine the pay factor. The maximum pay factor for each element is 2%. An additional 4% incentive will be applied to the lot payment if the sum of the pay factors for the individual elements for a lot is 6% or greater. The maximum volumetric pay factor for a lot is 12%.

Quality incentive allowances will be used to offset any price reductions.

A 1.05 pay factor will be applied to the lots of plant mix surfacing where the average in-place density for the lot (Xn) is from 94 percent to 95 percent, inclusive, of the target field Rice density and the range (R) is three or less. Quality Incentive allowances will be used to offset any price reductions.

All quality incentive allowance remaining after all price reductions have been deducted will be paid as a lump sum when all work on the item is complete.

Outlier Determination and Payment Adjustment for Volumetric Properties Only. If suspect test values are noted during construction, the Department will check plant production information, test equipment, processes, calculations, etc. for errors. If a problem is noted in the plant production, sampling or other process controlled by the Contractor, the test result will be considered valid until production is complete. If a problem is found with the testing or other Department process, the test result will be corrected or the test redone on material from the same sample, if possible. If a non-correctable testing problem is found, the result will be discarded, if possible another sample will be taken and the new result used in its place. If re-sampling is not possible, the Department may discard the test results for a sub-lot considered to be an outlier and recalculate the incentives and disincentives using the remaining results in the lot. The Department may follow standard QA guidelines to adjust lot sizes.

If no identifiable problem is found, no corrections will be made until production is complete.

The following outlier evaluation only applies to projects with 10 or more QA sub-lots.

After all production of this product is completed, the Department will determine the Standard Deviation and Mean of all the Department's test results for each volumetric property representing material produced after the initial targets were set. For each volumetric property test, the Z value is defined as the absolute value of the difference between the test value and the Mean, divided by the Standard Deviation. If the average of the Z values of the four volumetric properties in a sub-lot is greater than 2.00, the Department may consider the sub-lot an outlier. If more than one sub-lot outlier is identified in a lot, the test results will not be considered outliers. The Department will not adjust for outliers within the last lot of production.

The Department will discard the test results for a sub-lot considered to be an outlier and recalculate the incentives and disincentives using the remaining results in the lots. The Department will follow standard QA guidelines to adjust lot sizes.

5) Composition of Mixtures.

a) Job Mix Formula. Establish a target asphalt binder content. Base the target asphalt binder content on design and field gyratory mix test results. Mix Design Bulk Dry Aggregate Specific Gravities will be used during plant mix production unless otherwise directed by the Project Manager.

b) Plant Mix Sampling and Acceptance. Furnish the Project Manager a 45 lb (20 kilograms), or larger sample as directed, of plant mix surfacing material. The Project Manager will randomly select when plant mix samples are taken. Follow Sampling Procedure MT-303. A Department inspector will witness plant mix sampling. Furnish the sample to the inspector immediately after it is taken if requested or deliver the sample to the Departments designated test location after the inspector seals the sample in a tamper proof container. Plant mix sampling will be delayed until after the initial daily 100 tons (100 metric tons) of plant mix has been produced or when a hot plant is cleaned out (clean out) and 100 tons (100 metric tons) of plant mix has been produced. No sampling delay will be permitted at any other time, unless approved by the Project Manager.

6) Equipment.

a) Mixing Plants. Use mixing plants that produce a mix meeting the contract requirements.

b) Weigh System.

(1) Automatic Weighing. Use state certified automatic weigh systems to weigh materials. Ensure the weigh accuracy is within plus or minus 0.5 percent of the true weight throughout the use range.

Include in the system an automatic printer that provides the following information:

(a) Project No. (as shown on plans)
(b) Item Name (as shown on detail estimate)
(c) Date
(d) Time
(e) Ticket Number (consecutive)
(f) Haul Unit No.
(g) Net tons (metric ton) in load (to nearest 0.05 ton)
(h) A subtotal of tons (metric tons) for each haul unit since the beginning of the shift.
(i) An accumulated total for all haul units since the beginning of the shift.

Use a pre-programmed printer or one equipped to prevent manual override of any weight information. Have the weigh system tested, certified, and sealed by the State Bureau of Weights and Measures after each plant move and before production for a project. Immediately stop production should the printer malfunction or breakdown and do not resume until corrected. Delivery of material from storage or surge bins will be permitted only if the weight can be maintained within weigh specifications.

If an independent certified scale is within a 20 mile (32 km) round trip distance from either end of the project, the Project Manager will randomly designate the re-weighing of loaded vehicles, at least three times per project.

Re-test the plant weigh system any time the difference between the re-check and the plant system exceeds plus or minus one half of one percent of the load. Any weight difference will be addressed under Subsection 109.01.1.

(2) Manual Weighing. The Contractor may manually weigh and record weights instead of using an automatic weigh system. Ensure manual weighing includes platform scales meeting Subsection 301.03.2(C), a competent weigh person, and dump person.

Direct the weigh person to record, on Department furnished forms, weights to the nearest 100 pounds (45.4 kilograms) as well as the other required information regarding delivery and placement.

Tabulate and furnish a machine tape for the total of the weighed material delivered and placed on the roadway each shift. Certify that weights and totals furnished are a true and correct record of materials delivered and placed in the work. Deliver the records and totals to the Project Manager before 10:00 a.m. the next work day following the shift.

7) Safety Requirements. Install and maintain stairs, ladders, walkways, and all other plant facilities meeting State and Federal safety requirements.

Provide access to the tops of truck bodies for taking samples and mix temperature data.

8) Burner Fuel Restrictions. Use one of the approved fuels below to heat and dry aggregates.

a) Propane
b) Butane
c) Natural Gas
d) Fuel Oil (grades 1 and 2 only)
e) Coal

EPA Specification-Used Oil Fuel (EPA-UOF) may be used instead of the approved burner fuels provided the following requirements are met.

Physical Properties	Property Range
API Gravity	20-28
Viscosity at 12˚F (6˚C) (Saybolt Flurol)	10-20
Pour Point ˚F ˚C	+10 (-12)
Flash Point, min. Point ˚F ˚C	100 (37.8)
Water by Distillation %	Under 1
Solids by Separation %	Under 1
Ash %	Under 0.4
Sulfur	Average 0.5%
Kinematic Viscosity at 10˚F (37˚C) (centistokes)	54-100
Kinematic Viscosity at 12˚F (60˚C) (centistokes)	15-75

Chemical Properties

Element or Compound	Permitted Level
Vanadium	Under 100 ppm (100 mg/L)
Cadmium	Under 2 ppm (2 mg/L)
Chromium	Under 10 ppm (10 mg/L)
Lead	Under 100 ppm (100 mg/L)
Arsenic	Under 5 ppm (5 mg/L)
Total Halogens	Under 1,000 ppm (1,000 mg/L)
PCB's	Under 2 ppm (2 mg/L)

Furnish a copy of certified test results from the supplier for each load of EPA-UOF delivered to the project. Also furnish plant manufacturer information showing the plant burner is designed and equipped to burn EPA-UOF. Upon request, provide a one-quart (liter) sample of EPA-UOF from the tank on the project

Immediately stop using EPA-UOF fuel if burner flame outs or other evidence of incomplete combustion or mix contamination is evident. Begin using one of the other approved fuels to complete the work. Remove and replace all contaminated plant mix at contractor expense. No additional compensation will be allowed.

9) Hydrated Lime or Mineral Filler Feed System. Introduce the dry hydrated lime and mineral filler into drum dryer mixing plants just below the asphalt binder introduction point.

Use alternate lime introduction methods only with the Project Manager's written approval.

Ensure the system provides positive, accurate material feed and is automatically synchronized to the aggregate feed. Ensure the system indicates the weight entering the mixing unit on a time-coordinated basis.

Weigh using an automatic indicating electronic system. The lime or mineral filler may be weighed directly, or the storage container including lime or mineral filler may be weighed.

Provide a continuous digital readout showing the weight or rate of feed in tons (metric tons) per hour. Record the information using a production monitor/recorder system or by a de-cumulating balance ticket printing system. Record the information at minimum five-minute intervals or as directed.

Silo or storage container system weights are not used for acceptance during filling or transfer. Limit filling or transfer periods to one hour per three hours of plant operation. Record and furnish start and finish times for filling or transfer and the total quantity added.

Suspend mixing for erratic feeding or failure to feed hydrated lime or mineral filler to a minimum of 85% of the job mix formula. Do not resume until corrected or repaired.

10) Flow Rate Meter. Measure the asphalt binder discharged into the mixing unit using a flow rate meter with totalizer and temperature compensation.

Ensure the totalizer records up to 1,000,000 gallons (3,785,000 L) and is certified to plus or minus 0.20 percent of the measured quantity.

Use a flow rate meter and totalizer that automatically corrects to a temperature of 60˚F (16˚C) with an operating range of +60˚F (16˚C) to +450˚F (232˚C).

Locate the totalizer readout in the plant control room so it is readily accessible to the inspector.

Ensure the flow rate meter automatically shuts off any time asphalt binder is diverted or stops entering the mixing unit.

Calibrate the flow rate meter and totalizer before the start of the project and as necessary during production. The Project Manager will witness the calibration.

Provide the equipment and assistance for initial and subsequent calibration checks and furnish the Project Manager a copy of all calibration checks.

Use a calibration volume of at least 3,000 gallons (11,355 L). Ensure the weigh scales have been tested and certified.

Furnish the Project Manager one copy of a test report showing the asphalt binder specific gravity.

Spot check failure will require re-testing and certification of the above. The Project Manager will establish the spot check interval.

11) Production Monitor-Recorder. Use recording equipment that automatically monitors and records on a time coordinated basis, the aggregate, lime, mineral filler, and asphalt binder weight entering the mixing unit. The records may be continuous (chart recorder) or digital printout.

Ensure that chart recorders clearly record asphalt binder content changes of 0.1 percent or more and aggregate feed rate changes of 1.5 percent or more.

Ensure the digital printout equipment records the day's total production at minimum five-minute intervals, or the interval directed by the Project Manager.

Digitally display the aggregate and asphalt binder rates in tons (metric tons) per hour and daily totals. Display lime or mineral filler by tons (metric tons) per hour or on a de-cumulating balance.

Ensure the monitor system operates on unprocessed signals from measuring devices.

Provide the Project Manager continuous access to the recorder during production.

Submit the permanent record to the Project Manager daily.

Operate the production/monitor recorder at all times during production. Stop production when the recorder is not operational.

12) Asphalt Binder Mixture Preparation.

All Plants

Mix the aggregate and asphalt binder to produce a homogeneous mixture. Ensure all aggregates are thoroughly and uniformly coated with bitumen.

Remove, dispose of, and replace all mix that is damaged by burning, improper mixing, or fails to meet the specifications at Contractor expense.

Maintain the mix discharge temperature within the asphalt binder manufacturer's recommended mix temperature range.

The discharge temperature will be periodically checked and recorded.

Ensure the average of any three checks is within the specified limits.

Suspend plant operations when the mix discharge temperature is outside the range.

13) Roadway Equipment.

a) Pavers. Use self propelled pavers that spread, shape, and finish the combined plant mix material to the specified profile and cross slope.

Immediately stop paving if the paver tears, shoves, segregates or otherwise damages the plant mix, and repair or replace the paver before resuming paving operations.

Equip the paver with a mobile grade reference system that provides a uniform pavement profile. Ensure the paver maintains the transverse slope at all times and is able to adjust the slope throughout super-elevated curves.

Ensure auger extensions are used to match the screed width.

Equip the paver with an attachment that produces joints meeting requirement 18 below as the surfacing course is placed.

b) Trucks. Remove trucks from service that leak fluids. When directed, cover each load with canvas or other approved material to protect the mix at Contractor expense.

c) Rollers. Furnish and use rollers that compact the plant mix to the specified density. Remove rollers that crush the paving aggregates or otherwise damage the plant mix and replace the damaged plant mix at contractor expense.

d) Cleaning Agents. Do not use diesel fuel as a cleaning agent or as a release agent for any paving equipment or operations. Use a commercially manufactured release agent approved by the Project Manager

14) Existing Surface Preparation. Perform existing surface preparation meeting Section 204 requirements.

15) Aggregate Treatment and Tack Coat. Apply aggregate treatment and tack coat meeting the applicable requirements of Sections 407 and 410 and the Contract.

Apply aggregate treatment as directed before placing the plant mix.

Allow the aggregate treatment to cure at least 24 hours before placing the plant mix unless otherwise approved.

Apply tack coat on existing surfacing to be overlaid and between lifts when pavement is constructed in multiple lifts.

16) Surface Conditions, Weather Limitations, and Paving Dates. Stop plant mix paving when the surface temperature is less than 35˚F (2˚C); the surface is wet; the roadbed is unstable or the Project Manager determines adverse weather conditions prevent the proper handling, finishing, or compacting of the mix.

Complete all sections of plant mix pavement, to be open to traffic during winter suspension, to the full plan width and thickness, excluding seal coat. Complete this work meeting the specifications before the November 1st paving cessation date.

The Project Manager will suspend time assessment between November 1st and November 16th when the next scheduled significant work item is paving and all grading, gravel and other operations affecting the safe and convenient use of the roadway by the traveling public are complete.

Submit a written request to the Project Manager and obtain written approval in order to pave after November 1st. and before April 15th.

Plant mix surfacing placed after November 1st and before April 15th is at the Contractor's risk and subject to the following conditions.

- The surface temperature to be paved is at least 35˚F (2˚C), measured by the Project Manager.
- All applicable specifications are met.

Make permanent repairs and restore partially completed pavement to the required profile, section, and condition at Contractor expense before placing the remaining lifts.

This is not a waiver by the Department of any other contract requirement regarding the work sequence or traffic operation.

If the paving operation causes transverse joints spaced at less than one half mile (805 m), suspend work until the next April 15th.

No payment is made for the plant mix or asphalt on progress estimates between November 1st and April 15th for partial width or thickness.

Promptly repair damage to all partial width or thickness of plant mix surfacing used by traffic during this period for any reason including suspension of work due to adverse weather.

Provide all required interim traffic striping and traffic control on partially completed pavement at Contractor expense.

Failure to promptly make repairs and provide interim striping and traffic control is cause for the Department to perform or have the work performed and deduct the cost from monies due or that may become due the Contractor.

Payment for partial width or thickness pavement in acceptable condition will be made on the estimates following the end of the period on the next April 15th.

17) Spreading and Finishing. Place and spread the mix to the widest practical width on the approved surface. Place shoulder-widening material with approved equipment.

Establish and maintain line control for paving. The Project Manager will furnish the contractor the necessary information to establish these controls. Maintain the paving control line tolerance within 0.25 foot (75 millimeters) of a true line from the existing reference points.

Failure to maintain the paver control line within the specified tolerance is cause for corrective action or pavement removal and replacement, as directed by the Project Manager, at contractor expense.

Include the cost of furnishing horizontal line control in the plant mix pavement bid item.

Remove and replace segregated pavement areas behind the paver with new plant mix before initial rolling begins. Correct all segregated areas at Contractor expense.

On small or irregular areas, approaches, turnouts, around manholes, inlets, walls, and on other areas not readily accessible to a paver, plant mix may be spread to the specified thickness using a specialty paver or other approved methods. Compact these areas as directed.

Place the plant mix at all areas not covered under the ride specification meeting the surface tolerances meeting section 23 below.

Remove and replace all plant mix that is segregated, loose, broken, contaminated, damaged, or otherwise defective, with new plant mix that meets contract requirements at Contractor expense.

Roadways having a design Equivalent Single Axle Load (ESAL) of 100 or less may be opened to traffic or to haul units subject to Project Manager approval.

Roadways having a design ESAL of 100 or greater may be opened to traffic and haul units when the mat is compacted and the surface cools to 140˚F (60˚C).

18) Constructing Joints. Continuously place each lift and provide at least a 6-inch (150 mm) offset between longitudinal joints in successive lifts. Offset transverse joints in successive lifts by at least six feet (1.8 m).

Correct joints which do not meet the surface tolerance requirements in Section 23 of this provision.

Uniformly coat the exposed face of all joints, excluding those formed by echelon paving, with SS-1 emulsified asphalt or other approved asphalt just before placing the abutting course.

Construct longitudinal joints in the top lift of plant mix at the centerline or lane line. If these locations are not practical, construct the joint outside the wheel paths.

Construct a vertical transverse joint the full lift depth if the mix cools below the low temperature of the compaction temperature range recommended by the asphalt binder manufacture. Remove loose material, brush the joint face with asphalt, and compact the fresh mix against the joint face when paving is resumed.

Taper the end of paving lifts at bridge ends and on roadways under traffic to a minimum 50:1 ratio. When paving of the lift resumes, remove the taper and construct the transverse joint.

Taper the longitudinal paving joint edges at a 4:1 to 6:1 slope. Compact the joint between abutting passes to the specified plant mix density.

Sign the new pavement end at the close of work each day meeting the project's traffic control plan and the Contract.

Construct the joints at bridge ends or other rigid structures after the existing base is prepared and compacted. Apply a coat of SS-1 emulsified asphalt to the portions of structures abutting the plant mix pavement.

19) Compaction, Compaction Control Testing, and Density Acceptance Testing.

a) Compaction. Complete compaction rolling within the temperature range recommended by the asphalt binder supplier included in the mix design.

b) Compaction Control Testing. Perform all necessary density testing to control compaction.

Once the plant mix is spread, struck off, and surface irregularities are corrected, compact the plant mix to at least 93 percent of the field established Maximum Specific Gravity.

c) Leveling, Patching, and Thin Lifts. Density acceptance by Cores does not apply to initial plant mix lifts used for leveling ruts, sags, or other existing surface defects that are less than 0.10 foot (30 mm) thick.

20) Density Acceptance by Cores.

Provide core samples of the compacted plant mix from the roadway. Core locations will be randomly selected based on the tons (metric tons) of mix placed. Core the locations selected after all rolling is complete and before the roadway is opened to traffic. Areas within 1 foot (300 mm) of a free edge, or where the planned nominal thickness is less than 0.10 foot (30mm), are excluded from testing. The pavement density is determined from cores taken at randomly selected locations after all rolling is complete and before the roadway is open to traffic.

Perform the following work within the project site:

- Take cores after all rolling is complete
- Core two 4 inch (100 mm) or two 6 inch (150 mm) cores the full depth of the plant mix surfacing, extracted from within a 7.5 inch (190 mm) radius of each designated location. Mark the core as directed.
- Separate the plant mix lift to be tested from the total core. Cut the core to the actual lift thickness within plus or minus 0.15 inch (4 mm). The Department recommends using a saw to separate the lift to be tested from the total core. Perform this work within the project limits or other approved location.

The inspector will witness all of the above activities before traffic is permitted to use the plant mix lift being tested.

Furnish the core immediately to the inspector after it is removed, marked and separated. Do not remove the cores from the Inspector's visual control at any time. Recore as directed any time either the Contractor requirements or procedures of this provision (as outlined under part C 20) Density Acceptance by Cores are not met. The test results of the replacement core to be used in the QA evaluation for the lot represented will be the actual relative in-place density unless it exceeds 92%. If the actual in-place density of the replacement core is greater than 92%, then 92% will be used for the relative in-place density of that core in the QA evaluation.

The plant mix in the sub lot represented is considered to be not meeting density specifications.

Remove free water from each core hole, place and compact new plant mix (or approved cold patch mix) not exceeding 2 inch (50 mm) lifts to the finished surface immediately after the core is removed. Mark each core as directed by the inspector witnessing the coring.

MT 328 is used to establish the target Rice density. The Bulk Specific Gravity (MT-314) determined for each core will be divided by the target Rice density in effect at the time the plant mix was produced to determine the relative in-place density.

The approximate mix quantity represented by each sub-lot is 600 tons (600 metric tons). Additional locations and tests may be required. The quantity represented by 5 tests or approximately 3000 tons (3000 metric tons) of mix constitutes a lot whenever production schedules and material continuity permit. A lot represented by 3 to 7 consecutive random sub-lots will be established when there are short production runs, significant material changes, or other unusual characteristics of the work.

All costs of furnishing the cores will be considered incidental to Plant Mix Bituminous Surfacing items and no separate measurement or payment will be made.

21) Protection of Traffic and Roadway Structures.

a) Traffic Protection. Place traffic control devices meeting Section 618 requirements, and the approved traffic control plan.

At the end of each day's work, and when not in use, park all equipment at least 30 feet (9.2 m) from the outside edges of the traveled lane.

b) Protection of Roadway Structures. Protect roadway structures meeting Subsection 410.03.9 requirements.

22) Pavement Repair. Cut out the defective pavement to at least one-inch (25 mm) depth. Clean the sides and bottom of the hole and apply approved asphalt to the surfaces. Fill the hole with fresh mix, level, and compact to the specified density and surface smoothness.

23) Surface Tolerances. Meet the special provision requirements for ride. For all paved areas excluded from the “Ride Specification” finish the surface of each final lift to the specified grade and cross section. The Contractor will be notified of sections to be corrected within three working days after the surface was placed. Perform all corrective work at Contractor expense. The following values specify the maximum allowable variance and divergence from the mean constructed grade:

Surface	Total Variation	Rate
New Plant Mix Bituminous Surfacing	0.02 foot (6 mm)	0.20%
Plant Mix Overlays (greater than or equal to 90mm)	0.03 Foot (9 mm)	0.30%
Plant Mix Overlays (less than 90mm)	0.03 Foot (9 mm)	No Rate

The rate is applicable only to the longitudinal direction.

New plant mix surfacing includes the seal and cover, if the seal and cover has been applied.

The mean constructed grade for each section is the planned grade or a grade parallel to plan grade, acceptable to the Engineer.

Surfaces will be checked for compliance at joints, bridge ends, and other sections where ride characteristics or other evidence indicates surface tolerance is outside the specifications.

Surface smoothness is measured longitudinally in 100-foot (30.5 m) sections at 10-foot (3 m) intervals, and transversely at 4-foot (1.2 m) intervals. Correct out of specification plant mix surfacing by a method approved by the Engineer, including cold milling at least 0.12 foot (38 mm) deep, the full width of the defect but not less than the paver width and for 50 feet (15.2 m) each side of the defective pavement. Fill the milled area with like material and compact to the specified density.

Ensure the corrected pavement and adjoining surface meet the smoothness specifications.

Ensure transverse joints in lifts of plant mix surfacing or other lifts to be used by traffic for 15 days or more do not vary more than 3/8-inch (10 mm) from any point on a taut 25-foot (7.6 m) string line placed parallel to centerline.

New surfaces will be checked for a minimum of 100 feet (30.5 m) by placing the string line in half-length increments along the roadway in traffic lanes.

Corrected areas including new joints will be checked for meeting the surface tolerances.

24) Rumble Strips. Construct rumble strips when specified. Cut the rumble strips into the finished plant mix pavement. Use a machine equipped with a rotary type cutting head capable of making the cuts to the dimensions and pattern shown in the Detailed Drawings.

Establish a control line and locate the rumble strips on the shoulder 6-inches (152mm) from the outside edge of the travel lane. The offset may be adjusted to avoid longitudinal pavement joints. Do not place rumble strips where concrete median barrier rail or other roadside features prevent placement as specified.

If the seal and cover is not completed before winter shutdown, fog seal the finished rumble strips. Use SS-1 or CSS-1 emulsion for fog seal. Dilute the emulsion with water at a 1:1 ratio and apply at 0.05 to 0.15 gallons per square yard (0.20 to 0.60 liters per square meter).

Keep traffic off the fog seal until the emulsion has cured to no-tack.

Apply the fog seal to the rumble strip for each lane in the direction of travel for that lane.

Produce the rumble strips without tearing and snagging the pavement.

Remove and dispose of the waste material according to all applicable local, state, and federal regulations.

D. Method of Measurement

1) Plant Mix Pavement. Plant mix pavement is measured by the ton (metric ton) on approved scales after complete mixing of all ingredients. The pay weight includes the asphalt binder and mineral filler or hydrated lime in the mixture.

2) Asphalt Binder. Asphalt Binder is measured by the U.S. gallon (Liter) or the ton (metric ton) as specified to the nearest whole gallon (liter) or ton (metric ton), under Subsection 402.04, excluding anti-stripping additive.

3) Hydrated Lime. Hydrated lime is measured by the ton (metric ton) meeting Subsection 109.01. Hydrated lime exceeding 1.6 percent by total weight of mix is not measured for payment as hydrated lime.

4) Rumble Strips. Rumble strips are measured by the mile (kilometer) to the nearest tenth of a mile (tenth of a kilometer) along the centerline of the roadway, less all gaps in the rumble strips due to ramp terminals, objects, etc. Each individual line of rumble strips is measured separately.

Fog seal for rumble strips is not measured for payment.

5) Tack Coat. Tack coat is incidental to the plant mix surfacing and is not measured for payment.

E. Basis of Payment. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Plant Mix Pavement	Ton (metric ton)
Asphalt Binder	Gallon (liter) or Ton (metric ton)
Hydrated Lime	Ton (metric ton)
Rumble Strip	Mile (kilometer)

The unit price bid for rumble strips will be adjusted as follows:

Line Deviation From the True line	Price Adjustment
0.0 ft. to 0.15 ft. (50 mm) in 500 ft. (152 m)	None
0.15 ft. (50 mm) to 0.25 ft. (75 mm) in 500 ft. (152 m)	50% price reduction
> 0.25 ft (75mm) in 500 ft. (152 m)	Correct as directed

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

APPENDIX H1

State Test Case #8, Ohio:

ODOT SECTION 442A

Airport Pavement for <60,000# AGW

ODOT ITEM 442A
SUPERPAVE ASPHALT CONCRETE
AIRPORT PAVEMENT FOR <60,000# AIRCRAFT GROSS WEIGHT

Delete the Item index and add the following;

442A.00 SUPERPAVE (SP) ASPHALT CONCRETE, inclusive, and all other referenced parts of Ohio Department of Transportation, Construction and Material Specifications for Road and Bridge Construction, Current Edition, Section 400 are applicable under this SECTION 442A, except as modified herein.

Equivalent Terms for this Specification, and throughout application of Ohio Department of Transportation, Construction and Material Specifications for Road and Bridge Construction, Current Edition, are listed below:

District, Department, Engineer, District Engineer of Testing (DET) , Laboratory, Monitoring Team and all similar Highway agency terminology are synonymous with Airport Owner [or Owner Authorized Representative (OAR)]

Roadway, synonymous with Airport Pavement

442A.01 Description. This work consists of gyratory mix design, material, and quality control requirements for constructing a Superpave asphalt concrete pavement surface or intermediate course. The asphalt concrete pavement course consists of aggregate, and asphalt binder mixed in a central plant and spread and compacted on a prepared surface.

The requirements of Section 400 in its entirety apply, except as modified by this specification.

ITEM 401 ASPHALT CONCRETE PAVEMENTS—GENERAL

Delete section 401.19 Spreading and Surface Tolerances and replace it with the follow;

401A.19.1 Thickness: Thickness shall be evaluated for compliance by the Engineer to the requirements shown on the plans. Measurements of thickness shall be made by the Engineer using cores extracted for each sublot for density measurement.

401A.19.2 Smoothness: The final surface shall be free from roller marks. The finished surfaces of each course of the pavement, except the finished surface of the final course, shall not vary more than ⅜ inch when evaluated with a 16 foot straightedge. The finished surface of the final course of pavement shall not vary more than ¼ inch when evaluated with a 16 foot straightedge. The lot size shall be 2,000 square yards. Smoothness measurements shall be made at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made at the center of each paving lane. In the transverse direction, smoothness readings shall be made continuously across the full width of the pavement. However, transverse smoothness readings shall not be made across designed grade changes. At warped transition areas, straightedge position shall be adjusted to measure surface smoothness and not design grade transitions. When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.

Note. *This smoothness criterion has been established through prior coordination with aircraft manufacturers and aircraft/airport related associations and technical organizations. Any deviation from surface smoothness criteria for runway and/or taxiway pavement requires approval by the FAA.*

401A.19.3 Grade: The finished surface of the pavement shall not vary from the gradeline elevations and cross sections shown on the plans by more than ½ inch (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet) to determine the elevation of the completed pavement. The Contractor shall pay the cost of surveying of the level runs that shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer. The lot size shall be 2,000 square yards (square meters). When more than 15 percent of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates ¾ inch or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. The surface of the ground pavement shall have a texture consisting of grooves between 0.090 and 0.130 inches wide. The peaks and ridges shall be approximately 1/32 inch higher than the bottom of the grooves. The pavement shall be left in a clean condition. The removal of all of the slurry resulting form the grinding operation shall be continuous The grinding operation should be controlled so the residue from the operation does not flow across other lanes of pavement. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.
Note. *This grade criterion has been established through prior coordination with aircraft manufacturers and aircraft/airport related associations and technical organizations. Any deviation from surface grade criteria for runway and/or taxiway pavement requires approval by the FAA.*

Delete section 401.20 Asphalt Binder Price Adjustment.

ITEM 403 ASPHALT CONCRETE QUALITY CONTROL AND ACCEPTANCE

Delete Section 403.02 General and add the following:

403A.02 General The OAR will perform all acceptance testing necessary to determine conformance with the acceptance requirements and will be performed by the OAR at no cost to the Contractor. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be available for joint use by the Contractor for quality control testing and by the Engineer for acceptance testing and shall be calibrated by the testing organization prior to the start of operations. The Contractor must have adequate equipment for the performance of the tests required by these specifications. The Engineer shall have priority in use of the equipment necessary for acceptance testing. All Contractor personnel preparing laboratory compacted specimens shall be a state certified Superpave Field Testing Technician or equivalent acceptable to the Engineer. Sampling and testing shall be as specified with the exception that the Verification samples will be tested by the Engineer for each sublot.

Delete Section 403.06 Verification Acceptance (VA~~)~~

Delete Sections 403.06 Sampling C to F

ITEM 441 CONTRACTOR MIX DESIGN AND QUALITY CONTROL—GENERAL

Delete all references to 1H mixes

Delete all reference to Table 441.02-1

Delete all of section 441.06 Monitoring

Delete section 442.02 and substitute the following:

442A.02 Mix Design. Design the mixture composition for a Type A, B, or C mix according to 441.02 and the most recent *Asphalt Institute Superpave Mix Design Manual* (SP-2) for design procedures and material properties except as modified by this subsection. Include in the JMF submittal the standard ODOT cover and summary page; all printouts from the gyratory compactor (all gyratory points not necessary); and analysis covering the required mix properties. Submit one compacted gyratory sample and loose mix for compaction of another sample, in addition to a 5-pound (2000 g) loose sample, for each JMF.

The Contractor may use the Marshall flow test in design as an indicator of potential for excess tenderness.

Traffic Levels: The requirements for SP Asphalt Concrete mixtures are based on the design traffic level of the project, according to the lane current average daily truck traffic (Lane ADTT) for highways as equated to Aircraft Gross Weight. The three traffic levels are as shown in Table 442A.02-1.

Table 442A.02-1

Superpave Traffic Levels			
Traffic Level	**Mix Type**	**Lane ADTT**	Aircraft Gross Weight, Pounds
A	A	<4000	<12,500
B	B	<4000	12,500 to <60,000
C	C	>4000	12,500 to <60,000

The traffic level(s) for the project are as specified in the Contract. A Type of SP mix one traffic level higher than the traffic level specified in the Contract may be substituted, at no cost to the Airport Owner (i.e. Traffic Level B may be substituted for Traffic Level A, etc.).

Supply aggregate according to the Traffic Levels as follows unless otherwise shown in the specifications or on the plans.

Table 442A.02-2

Traffic Level	**Nini**	**Ndes**	**Nmax**	**Coarse Aggregate Angularity**	**Fine Aggregate Angularity**	**Flat and Elongated Particles**	**Sand Equivalent**
A & B	7	65	105	95 * /90 **	44	10	45
C	7	65	105	100 * /100 **	44	10	50

Submit aggregate to be used to the Laboratory for approval a minimum of 3 weeks before submitting a JMF for approval. If fine aggregate is from crushed carbonate stone or air-cooled blast furnace slag, the OAR will not require the fine aggregate angularity (FAA) test. The OAR will allow a blend of a material not meeting the FAA test requirements with a material that meets the `FAA, but calculate the FAA result based on the individual OAR FAA results and actual blend percentages. Obtain OAR approval of any blends.

The restricted zone does not apply. Use control points according to SP-2, except as specified in Table 442A.02-3.

TABLE 442A.02-3 AGGREGATE GRADATION REQUIREMENTS

Sieve Size	All Pavements				
	Percent by Weight Passing Sieves				
	1 1/2 in NMAS	1.0 in. NMAS	3/4 in NMAS	1/2 in NMAS	3/8 in NMAS
	(37.5 mm)	(25.0 mm)	(19 mm)	(12.5 mm)	(9.5 mm)
	Control Points	Control Points	Control Points	Control Points	Control Points
1.5 in (50.0 mm)	100 to 100				
1.25 in (37.5 mm)	90 to 100	100 to 100			
1.0 in.(25.0 mm)		90 to 100	100 to 100		
¾ in.(19.0 mm)	90 to 100		90 to 100	100 to 100	
½ in.(12.5 mm)				90 to 100	100 to 100
⅜ in.(9.5 mm)					90 to 100
No. 4(4.75 mm)					
No. 8(2.36 mm)	15 to 41	19 to 45	23 to 49	28 to 58	32 to 67
No. 16(1.18 mm)					
No. 30(0.600 mm)					
No. 50 (0.300 mm)					
No. 100(0.150 mm)					
No. 200 (0.075 mm)	0 to 6	1 to 7	2 to 8	2 to 10	2 to 10

The combined aggregate gradation shall be classified as coarse-graded when it passes below the Primary Control Sieve (PCS) control point as defined in Table #4. All other gradations shall be classified as fine-graded.

TABLE 442A.02-4 - GRADATION CLASSIFICATION

PCS Control Point for Mixture Nominal Maximum Aggregate Size (% Passing)					
Nominal Maximum Aggregate Size	37.5 mm	25.0mm	19.0 mm	12.5 mm	9.5 mm
Primary Control Sieve	9.5 mm	4.75 mm	4.75 mm	2.36 mm	2.36 mm
PCS Control Point (% Passing)	47	40	47	39	47

At the discretion of the design engineer, the 37.5 mm, 25.0 mm, and 19.0 mm NMAS gradations may be used for base and/or intermediate course layers; the 9.5 mm and 12.5 mm NMAS gradations may be used for leveling course layers; and the 12.5 mm and 19.0 mm NMAS gradations are normally specified for surface course layers. All surface course layers must be specified as the fine-graded aggregate classification.

Ensure that the F/A ratio is a maximum of 1.2. Use a 2-hour cure in design process.

If more than 15 percent fine aggregate not meeting FAA is used, perform a loaded wheel test (LWT) according to Supplement . To estimate a LWT sample mix volume, use the bulk density from gyratory specimens at Ndes. Results less than 0.20 inch (5.0 mm) at 120 °F (49 °C) are considered passing.

The Contractor may use reclaimed asphalt concrete pavement according to 401.04, with the following additions:

- The RAP shall not contain any material that has been treated with a coal-tar sealer rejuvenator or material that contains coal-tar.
- The maximum percent of RAP allowed in the Job Mix Formula is 15% which may be increase up to 30% if the asphalt binder grade is lowered by one grade to account for hardening with the addition of the RAP according to Table 442A.02-5

TABLE 442A.02-5 – RECOMMANEDATION ON THE USE OF RAP

Type of Mix	Recommended Virgin Binder Grade	RAP Percentage		
		Recovered RAP Grade		
		PGXX-22 Or Lower	PGXX-16	PGXX-10 Or Higher
Surface and Base Mix	No Change in Binder Selection	<20%	<15%	--
Base Mix	Select virgin binder in grade softer than normal (i.e. select a PG58-28 if a PG64-22 would normally be used)	15%-30%	15%-30%	--
Surface and Base Mix	Follow recommendations from blending charts	--	--	<10%

Test design volumetric properties at . Test for the required criteria. Ensure that the design asphalt binder content is established at 4.0% Air Voids and that the VMA is not less than the minimum values of Table 442A.02-4.

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TABLE 442A.02-4 VMA CRITERIA

Mix	VMA (percent minimum)
9.5 mm	15
12.5 mm	14
≥19.0 mm	13

Delete Section 442.03 Type B Mix Design and Table 442.03-1

Delete Section 442.04 Asphalt Binder and substitute the following:

442A.04 Asphalt Binder. For Traffic Levels A in Table 442A.02-1 use a PG 64-28 asphalt binder, for Traffic Levels B use a PG 70-22 asphalt binder and for Traffic Level C use PG 70-22M asphalt binder.

The minimum total asphalt binder content for a surface course is 5.7 percent.

Delete Section 442.05: Quality Control and substitute the following:

442A.05: Quality Control. Conform to 441.09, except as specified in this subsection. Ensure that plant operation and quality control testing conform to the Contractor's Quality Control Program (QCP) as provided to the OAR.

Use a gyratory compactor conforming to the requirements of Superpave. If the gyratory compactor was moved to the plant before production, calibrate it and present the results to the OAR. Condition samples for air voids for 2 hours.

Determine bulk gravity for air voids determination on specimens compacted to . Once each day for the first 3 production days compact one set of specimens to . Ensure that density at is less than 98.0 percent of Maximum Specific Gravity (MSG). The OAR will not allow production to continue if is greater than or equal to 98.0 percent of MSG unless acceptable corrections and retest are made.

If the design gradation requires an LWT test, take a sample sufficient to run a LWT test once each day for the first 3 days and test it according to Supplement 1057. The Contractor may perform the LWT test in the Contractor's Level 2 laboratory, but must compact the sample the same day the sample was taken, cure it overnight, and test it the following day. Give the test result and sample density to the OAR the day of the LWT test. Report the LWT data on the Quality Control Report.

Delete section 442.06 Compaction and replace with the following:

442A.06 Compaction: Compaction sampling, testing and acceptance shall be in accordance with Item 446 as updated below;

Delete Section 446.06 Joints and replace with the following:

446A.06 Joints: Construct joints according to 401.17 Cold longitudinal joints in mainline pavement will be tested according to 446.05.

Delete Section 446.07 Basis of Payment.

Delete section 442.07 and replace with the following:

442A.07 Acceptance. Final acceptance will be based on this Section 400 and Item 442A as edited herein.

Add the following additional requirements:

442A.07.1 Test Section [or Initial Production Lot: Prior to full production, the contractor shall prepare and place a quantity of HMA mixture according to the job mix formula. As a minimum, and since joint density is require for acceptance, the amount of mixture shall be sufficient to construct a test section a minimum of 300 ft. long and 30 ft. wide**,** placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. A cold joint is an exposed construction joint at least 4 hours old or whose mat has cooled to less than 160° F. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. The test section must be evaluated for acceptance as a single lot in accordance with the acceptance criteria as specified in Section 400, except as modified herein.

442A.07.2 Skid Resistance Surfaces/Saw-Cut Grooves. If shown on the plans, skid resistant surfaces for HMA pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving. Transverse grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1-½ inches center to center configuration. The grooves shall be continuous for the entire length of the groove. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for saw-cut grooves shall meet the following:

- **Alignment tolerance** – Plus or minus 1-½ inches in alignment for 75 feet.

- **Groove tolerance** – Minimum depth 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch. Maximum depth 5/16 inch. Minimum width ¼ inches. Maximum width 5/16 inch.

- **Center-to-center spacing** – Minimum spacing 1-3/8 inches. Maximum spacing 1-5/8 inches. Grooves shall not be less than 6.0 inches and not more than 18.0 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with governing laws and regulations. All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

Delete section 442.08 and add the following:

442A.08: Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

442A.08.1: Measurement. The HMA placed shall be measured by the number of cubic yards of mixture used in the accepted work.

442A.08.2: Payment: Payment for an accepted lot of HMA pavement shall be made at the contract unit price per cubic yard

442A.08.3 Basis for Adjusted Pay Factor: The pay factor for each individual lot shall be calculated in accordance with the procedures outlined herein

442A.08.3: Total Project Payment. The total project payment for HMA pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons of HMA mixture used in the accepted work. In the event a lot is identified for removal and replacement, the Engineer may decide to allow the rejected lot to remain in place. In that case, if the Engineer and the Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price AND THE TOTAL PROJECT PAYMENT LIMITATION SHALL BE REDUCED BY THE AMOUNT WITHHELD FOR THE REJECTED LOT. Payment in excess of 100 percent for accepted lots of HMA pavement shall be used to offset payment for accepted lots of HMA pavement that achieve a lot pay factor less than 100 percent. The calculation of excess and offset shall be applied as equivalent amounts.

Item	**Unit**	**Description**
442A	Cubic Yard	Superpave Asphalt Concrete Surface, XX.X(1) mm, Type A (446A)
442A	Cubic Yard	Superpave Asphalt Concrete Surface, XX.X(1) mm, Type B (446A)
442A	Cubic Yard	Superpave Asphalt Concrete Surface, XX.X(1) mm, Type C (446A)
442A	Cubic Yard	Superpave Asphalt Concrete Intermediate, XX.X(1) mm, Type A (446A)
442A	Cubic Yard	Superpave Asphalt Concrete Intermediate, XX.X(1) mm, Type B (446A)
442A	Cubic Yard	Superpave Asphalt Concrete Intermediate, XX.X(1) mm, Type C (446A)

Note: (1) Were XX.X represents the Nominal Maximum Aggregate Sizes of 37.5, 25, 19, 12.5, & 9.5 mm as designated in Table 442A.02-3

APPENDIX H2

ODOT SECTION 442

SUPERPAVE ASPHALT CONCRETE

ITEM 442 SUPERPAVE ASPHALT CONCRETE

442.01 Description. This work consists of gyratory mix design, material, and quality control requirements for constructing a Superpave asphalt concrete pavement surface or intermediate course. The asphalt concrete pavement course consists of aggregate, and asphalt binder mixed in a central plant and spread and compacted on a prepared surface.

The requirements of Item 441 apply, except as modified by this specification.

442.02 Type A Mix Design. Design the mixture composition for a Type A mix according to . and the most recent *Asphalt Institute Superpave Mix Design Manual* (SP-2) for design procedures and material properties except as modified by this subsection. Include in the JMF submittal the standard Department cover and summary page; all printouts from the gyratory compactor (all gyratory points not necessary); and analysis covering the required mix properties. Submit one compacted gyratory sample and loose mix for compaction of another sample, in addition to a 5-pound (2000 g) loose sample, for each JMF.

The Contractor may use the Marshall flow test in design as an indicator of potential for excess tenderness.

Supply aggregate according to the lane current average daily truck traffic (Lane ADTT) as follows unless otherwise shown on the plans:

Where:

Current ADT = current average daily traffic count from the plans
= percent trucks per day from the plans

TABLE 442.02-1 GYRATION LEVEL AND MATERIAL REQUIREMENTS

Lane ADTT	Nini	Ndes	Nmax	Coarse Aggregate Angularity	Fine Aggregate Angularity	Flat and Elongated Particles	Sand Equivalent
<4000	7	65	105	95 * /90 **	44	10	45
>4000	7	65	105	100 * /100 **	44	10	50

* Percent fractured (one or more faces) according to ASTM D5821
** Percent fractured (two or more faces) according to ASTM D5821

Submit aggregate to be used to the Laboratory for approval a minimum of 3 weeks before submitting a JMF for approval.

If fine aggregate is from crushed carbonate stone or air-cooled blast furnace slag, the Department will not require the fine aggregate angularity (FAA) test. The Department will allow a blend of a material not meeting the FAA with a material that meets the FAA, but calculate the FAA result based on the individual Department FAA results and actual blend percentages. Obtain Department approval of any blends.

The restricted zone does not apply. Use control points according to SP-2, except as specified in Table 442.02-2.

TABLE 442.02-2 AGGREGATE GRADATION REQUIREMENTS

Sieve Size	9.5 mm mix (% passing)	12.5 mm mix (% passing)	19 mm mix (% passing)
1 1/2 inch (37.5 mm)			100
3/4 inch (19 mm)		100	85 to 100
1/2 inch (12.5 mm)	100	95 to 100	90 max
3/8 inch (9.5 mm)	90 to 100		
No. 4 (4.75 mm)	70 max		
No. 8 (2.36 mm)	32 to 52	32 to 45	28 to 45
No. 200 (75 µm)	2 to 8	2 to 8	2 to 6

Ensure that the F/A ratio is a maximum of 1.2. Use a 2-hour cure in design process.

If more than 15 percent fine aggregate not meeting FAA is used, perform a loaded wheel test (LWT) according to Supplement . To estimate a LWT sample mix volume, use the bulk density from gyratory specimens at Ndes. Results less than 0.20 inch (5.0 mm) at 120 °F (49 °C) are considered passing.

The Contractor may use reclaimed asphalt concrete pavement according to .. Test design volumetric properties at . Test for the required criteria. Ensure that the VMA is not less than the minimum values of Table 442.02-3.

TABLE 442.02-3 VMA CRITERIA

Mix	VMA (percent minimum)
9.5 mm	15
12.5 mm	14
19.0 mm	13

442.03 Type B Mix Design. Apply the mix design specified in . for a Type A mix except as modified by this subsection:

Modify the Coarse Aggregate Angularity of Table 442.02-1 according to Table 442.03-1.

TABLE 442.03-1

Lane ADTT	Coarse Aggregate Angularity
<4000	65 * /65 **
>4000	75 * /70 **
* Percent fractured (one or more faces) according to ASTM D5821 ** Percent fractured (two or more faces) according to ASTM D5821	

Ensure that at least 50 percent by weight of virgin fine aggregate is aggregate meeting FAA or is crushed carbonate stone or air-cooled blast furnace slag. Modify the No. 8 (2.36 mm) sieve requirement for a 12.5 mm mix in Table 442.02-2 to 34 to 40 percent. Apply an F-T value of +2 according to . and ..

442.04 Asphalt Binder. Use a PG 70-22M asphalt binder for surface courses and a PG 64-28 asphalt binder for intermediate courses.

The minimum total asphalt binder content for a surface course is 5.7 percent.

442.05 Quality Control. Conform to ., except as specified in this subsection. Ensure that plant operation and quality control testing conform to the Contractor's Quality Control Program (QCP).

Use a gyratory compactor conforming to the requirements of Superpave. If the gyratory compactor was moved to the plant before production, calibrate it and present the results to the DET. Condition samples for air voids for 2 hours.

Determine bulk gravity for air voids determination on specimens compacted to . Once each day for the first 3 production days compact one set of specimens to . Ensure that density at is less than 98.0 percent of MSG. The Department will not allow production to continue if is greater than or equal to 98.0 percent of MSG unless acceptable corrections and retest are made.

If the design gradation requires an LWT test, take a sample sufficient to run a LWT test once each day for the first 3 days and test it according to Supplement . The Contractor may perform the LWT test in the Contractor's Level 2 laboratory, but must compact the sample the same day the sample was taken, cure it overnight, and test it the following day. Give the test result and sample density to the DET the day of the LWT test. Report the LWT data on the Quality Control Report.

442.06 Compaction. Cease production if compaction causes bumps in the mix or the mix is excessively tender.

442.07 Acceptance. The Department will base acceptance of the asphalt concrete mix on the item specified in the Contract (i.e., Item , Item).

442.08 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	**Unit**	**Description**
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type A (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type B (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type A (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type B (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 19 mm, Type A (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 19 mm, Type B (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 9.5 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 9.5 mm, Type B (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type B (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type B (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course 19 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 19 mm, Type B (448)

APPENDIX I1

State Test Case #9, Washington:

WSDOT Divisions 5-04A and 9-03.8A

Airport Pavement for <60,000# AGW

[Note to the Engineer:

1) **The most recent version of Washington State (WSDOT) Standard Specifications (M 41-10) can be found at http://www.wsdot.wa.gov/publications/manuals/M41-10.htm**

Relevant to the proper execution of a WA SSAP Specification for GA Airports are mainly;

- **a. Division 1 General Requirements; specifically:**
  - **i. 1-01 Definitions and Terms**
  - **ii. 1-02 Bid Procedures and Conditions**
    - **a. 1-02.1 Prequalification of Bidders**
    - **b. 1-02.3 Estimated Quantities**
  - **iii. 1-06 Control of Material**
    - **a. 1-06.2 Acceptance of Materials**
    - **b. 1-06.2(2) Statistical Evaluation of Materials for Acceptance.**
  - **iv. 1-09 Measurement and Payment**
    - **a. 1-09.6 Force Account**
- **b. Division 4-06 Asphalt Treated Base**
- **c. Division 5 Surface Treatments and Pavements; specifically:**
  - **i. 5-02 Bituminous Surface Treatment**
  - ***ii.* 5-04 Hot Mix Asphalt *[This Division is important for substitution of P-401].***
    - **a. 5-04.3(7)A Mix Design**
    - **b. 5-04.3(8)A Acceptance Sampling and Testing – HMA Mixture**
    - **c. 5-04.3(8)A7 Test Section – HMA Mixture**
    - **d. 5-04.3(10) Compaction**
    - **e. 5-04.3(10)B2. Test Section – Compaction**
    - **f. 5-04.5(1) Quality Assurance Price Adjustments**
- **d. Division 9 (Materials); specifically:**
  - **i. 9-00 Definitions and Tests**
  - **ii. 9-02 Bituminous Materials**
  - ***iii.* 9-03.8 Aggregates for Hot Mix Asphalt *[Important for substitution of P-401].***
    - ***a.* 9-03.8(2) HMA Test Requirements*[Volumetrics, HMA Class]***
    - ***b.* 9-03.8(6) HMA Proportions of Materials *[Agg. Gradation]***
    - **c. 9-03.8(7) HMA Tolerances and Adjustments *[Acceptance]***
  - **iv. 9-04 Joint and Crack Sealing Materials**

2) **One companion document for the Washington State Standard Specifications (M 41-10) is the Construction Manual (M 41-01). This manual can be found at: http://www.wsdot.wa.gov/publications/manuals/M41-01.htm**
   The Construction Manual contains the sample forms referenced in M 41-10.
3) **The other companion document for the WSDOT Standard Specifications (M 41-10) is the Materials Manual (M 46-01) This manual can be found at: http://www.wsdot.wa.gov/publications/manuals/M46-01.htm**
   The Materials Manual contains the Test Procedures (SOPs and FOPs) referenced in M 41-10. (see 9-00.9 Field Test Procedures, on page 9-2 of M 41-10).

4) **The selection of asphalt binder grade is documented in Figure 1 of "Superpave in Washington State" (dated 4/3/2002) which can be found at: http://www.wsdot/biz/mats/pavement/Superpave_in_Washington_State.pdf However this has been changed by Item "PG Oil Binder Selection" of the WAPA/WSDOT Joint Task Force Meeting minutes, (dated 2/27/2003) which can be found at: http://www.wsdot.wa.gov/biz/construction/Teams/WAPA/022703wapa.pdf**
5) **Other Washington State (WS) DOT Manuals and Guides can be found at http://www.wsdot.wa.gov/publications/manuals/index.htm**

Noteworthy items regarding the WA Standard Specifications which affect this example SSAP are as follows:

6) **Washington State DOT (WSDOT) started to transition from Hveem to Superpave Mix Design in 2001, and completed this process in 2004. Their mix designs are purely based on volumetrics.**
7) **The DOT does all acceptance testing.**
8) **Acceptance of HMA – mixture and HMA – Compaction is separate, with regards to; test sections, lot and sublots, test frequency, acceptance and pay factor calculation.**
   a. **HMA – Mixture has three levels of acceptance (see 5-04.3(8)A);**
      i. **by statistical evaluation when more than 2,500 tons.**
      ii. **by nonstatistical evaluation when less or equal to 2,500 tons.**
      iii. **by commercial evaluation for minor repairs and other non-structural applications.**
   b. **HMA – Compaction is accepted based on statistical evaluation (see 5-04.3(10)B3, Test Results), except when lifts are thinner than 0.1 foot.**
   c. **For HMA – Mixture; a lot is the total quantity of material or Work produced for each job mix formula (JMF) placed. Sublots shall be approximately uniform in size with a maximum sublot size of 800 tons.**
   d. **For HMA – Density; a lot will be the lesser of a single day's production or 400 tons. Each density lot is divided into 5 sublots. (see 5-04.3(10)B1). Density is tested by nuclear gauge.**
9) **WSDOT specifies its mixtures by Class and PG grade, or as Commercial HMA (see 5-04.4 and 5-04.5). For example; "HMA CL. ½ In. PG 64-28". The CL. ½ In. represents a ½" Nominal Maximum Aggregate Size (see 9-03.8(6) and the foot note in 9-03.1(5)B).**
   In this SSAP this example HMA will therefore be specified as follows: "½ In NMAS, PG 64-28".
10) **Terminology: In the WSDOT Standard Specifications, 1-01.3, this refers to Division 1, Section 01, and Subsection 3. For simplicity in this SSAP, this will be referred to as Division 1-01.3, or just 1-01.3.]**

WSDOT Division 5-04A;

Hot Mix Asphalt
Airport Pavement for <60,000 lbs. Aircraft Gross Weight (AGW)

Division 5-04, and all other referenced Divisions of the Standard Specifications (M 41-10) issued by the Washington State Department of Transportation (WSDOT), current edition, are applicable under this Division 5-04A, except as modified herein.

In Division 1-01.3 "Definitions", and in all other Divisions of the WSDOT Standard Specifications and related Documents, equivalent terminology is as follows:

- Commission, Washington State Transportation Commission, synonymous Airport Owner [or Owner Authorized Representative]
- Contracting Agency, synonymous Airport Owner [or Owner Authorized Representative]
- Department, Department of Transportation, synonymous Airport Owner [or Owner Authorized Representative]
- Engineer, Project Engineer, synonymous Airport Owner [or Owner Authorized Representative]
- Federal Highway Administration, synonymous with Federal Aviation Administration (FAA)
- Highway, Roadway, Traveled Way, synonymous with Airport Pavement
- Director, synonymous with the Airport Manager (or CEO)
- Laboratory, synonymous with the Laboratory retained by the Airport Owner
- Offices of Structure Design, synonymous with the Engineering Firm or Department
- The Special Provisions, synonymous with the project specifications.

In addition:

- Airside pavements are all pavements traveled by aircraft
- Landside pavements are all pavements not traveled by aircraft (typically pavements located outside of the security fence).

Division 1 "GENERAL REQUIREMENTS"

1-02.2; delete: The Contracting Agency will place review copies of the Plans and Specifications on file in the offices of:

1. All Regional Administrators of the Department,
2. The County Engineer of the county in which the Work is located, and
3. These plans service offices of the Associated General Contractors of America: Seattle, Spokane, and Tacoma, WA.

1-02.2; add: The Airport Owner [or Owner Authorized Representative] will place review copies of the Plans and Specifications on file in the offices of:

1. the Airport Administration,
2. the Aeronautics Department/Airports Division of WSDOT, and
3. if Federal Aid is involved; the Regional FAA/Airports Division office.

1-02.3 "Estimated Quantities"
[Note to the Engineer:
WSDOT pays based on actual quantities used, as stated in 1-02.3 "Estimated Quantities".

If your project quantities can be considered accurate, and only a not-to-exceed project budget is available, the following text may be substituted for 1-02.3, and applied as a change throughout the project documents:

New 1-02.3 "Quantities and Contract Price"; The quantities presented in the Bid Documents have been carefully determined and are expected to be accurate. Therefore significant deviations (suggested as >10%) from these quantities are not expected, and the Contract Price is considered to be 100% pay. The work is all inclusive and incidental to the bid items. Contractor shall (as stated in 1-02.4(1)) investigate and assure himself that for all practical purposes the quantities are correct, and if found differently this shall be so noted in Contractor's bid. Any work Contractor does not consider incidental to the bid items, shall be listed separately and be part of Contractor's bid. If the Engineer determines that a Change Order is warranted, then 1-04.4 "Changes" shall apply. Delete; 1-04.6 "Variation in Estimated Quantities"].

Insert:
1-05.5; Contractor Quality Control (QC)
1-05.5(1); General. For Airside pavements, the Contractor shall develop and submit a Quality Control Program in accordance with Section 100, Contractor Quality Control, of the General Provisions, FAA AC 150/5320-10C, Standards for Specifying Construction of Airports, except as modified herein. The Program shall address all elements which affect the quality of the pavement including, but not limited to:

- Mix Design
- Aggregate Grading
- Quality of Materials
- Stockpile Management
- Proportioning
- Mixing and Transportation
- Placing and Finishing
- Joints
- Compaction
- Surface Smoothness

At a minimum the Contractor shall perform the following WSDOT test methods once per sublot:

- TM 6 Moisture Content of mix
- T27/11 Sieve Analysis of Fine, Course, and Mineral Aggregates
- T166 Bulk Specific Gravity (Gmb) for compacted mix using SSD
- T168 Sampling Bituminous Paving Mixture
- T209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mix (Gmm)
- T308 Asphalt Binder Content by Ignition Oven
- T312 Preparing and Determining the Density of HMA
- T712 Standard Method of Reducing Bituminous Paving Mixtures
- T716 Method of Random Sampling for Locations of Testing and Sampling
- T731 Method for Determining Volumetric Properties of HMA.

The Contractor shall determine volumetric properties for Va, VMV, and VFA in accordance with the test methods listed above.
Prior to the start of production, a Random Sampling Plan shall be submitted to the Engineer in accordance with WSDOT Test Method 716.

1-05.5(2); QC/Process Control Documentation. For Airside pavements, the Contractor shall provide up to date process control charts depicting all of the QC data in relation to the Upper and Lower Control Limits and JMF targets for asphalt content, gradation, and each volumetric property. Up to date control charts shall be posted at the production facility. If the Engineer requests, the Contractor shall input to Statistical Analysis of Material (SAM) all QC tests by the following day of production. SAM is located at:
https://business.wsdot.wa.gov/Materials/SAMui/samlogin.aspx
A daily summary report, consisting of all QC test results, shall identify the following:

- Daily tonnage tested
- Project totals to date
- Number of QC tests performed

The QC program samples shall be independent of the acceptance samples.
The cost of Contractor's QC program shall be included in the unit bid price for the HMA mixture.

1-05.5(3); Laboratory Testing. For Airside paving projects, the Contractor shall provide a fully equipped asphalt laboratory located at the plant or at the job site. It shall be available for joint use by the Contractor for quality control testing and by the Engineer for acceptance testing, and must have adequate equipment for the performance of all tests required by these specifications. The Engineer shall have priority in the use of the laboratory and its equipment.
The effective working area of the laboratory shall be a minimum of 150 square feet with a ceiling height of not less than 7.5 feet. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70 degrees F +/- 5 degrees.
Test equipment shall be verified utilizing WSDOT or AASHTO R-18 verification criteria. All equipment shall have a unique identification number. A tag bearing the verification expiration date will be placed on all applicable equipment. Copies of the verification worksheets shall be submitted to the Engineer prior to paving.

1-06.2(2)B; After; "As an incentive to produce superior quality material, a pay factor greater than 1.00 may be obtained with the maximum pay factor being 1.05.", add; Lots with pay factors greater than 1.00 can compensate for lots with pay factors less than 1.00, for each constituent of the lot separately. Regardless of individual pay factors and Composite Pay Factor (CPF), the total project payment can not exceed 100% of the contract price.

1-09.6; add: Force Account applies to change orders only.

1-09.9; delete: The basis of payment will be the actual quantities of work performed according the Contract and as specified for payment.
Replace this with; Total project payment can not exceed 100% of the contract price, except for payment of change orders as approved by the Engineer. Deleted work and Composite Pay Factors will be accounted for in the total project payment.

5-04.1; add:

A. Traffic Levels. Performance-Graded (PG) Asphalt Binder and SP aggregate consensus property and SP HMA design requirements are dependent on Traffic Levels in terms of 18,000 pounds Equivalent Single Axle Loads (ESALs) as defined by AASHTO M-323. The Traffic levels have been correlated with aircraft gross weights as provided in Table # 1.

Table #1 – Traffic Level Correlation for Superpave HMA Mixtures.

Traffic Level	Million ESALs	Aircraft Gross Weight, (#)
A	<0.3	<12,500
B	0.3 to <3.0	12,500 to <60,000

B. In 9-03.8(2); HMA Test Requirements (mix design), N(des) = 50 Gyrations shall be used for Traffic Level A, and N(des) = 65 Gyrations shall be used for Traffic Level B.

C. Pavement types and Specification differences.
- Airside pavements for Aircraft with AGW <12,500 lbs shall be constructed using the WSDOT Standard Specification (M 41-10) as amended (modified) in this SSAP, and only statistical evaluation shall apply. No need for Binder grade bumping.
- Airside pavements for Aircraft with AGW >12,500 lbs (but less than 60,000 lbs) shall be constructed using the WSDOT Standard Specification (M 41-10) as amended in this SSAP, and only statistical evaluation shall apply. The Asphalt Binder grade shall be bumped once.
- Landside pavements shall all be constructed using the unmodified WSDOT Standard Specification (M 41-10), and no binder grade bumping.
- For small repair work (Airside and Landside) the unmodified WSDOT Standard Specification (M 41-10), and Commercial Evaluation shall be used.

5-04.2; following: "If utilized, the amount of RAP shall not exceed 20-percent of the weight of aggregate in the mix.", insert: For surface courses the amount of RAP is limited to 15% of the total weight of the mix. The blend of old binder (contained in the RAP) and the new binder shall meet the specified PG grade. This information shall be part of the mix design submittal.

5-04.2; following: "The grade of asphalt binder shall be as required by the Contract.", insert: "The asphalt binder grade shall be selected as stated in document;
http://www.wsdot.wa.gov/biz/construction/Teams/WAPA/022703wapa.pdf
and more specific for location as shown in figure 1. of document;
http://www.wsdot/biz/mats/pavement/Superpave_in_Washington_State.pdf

5-04.3(7)A1.; add:

I) No HMA mixture for payment will be produced until a JMF has been approved in writing by the Engineer[Owner Authorized Representative]. The JMF must be submitted to the Engineer [Owner Authorized Representative] at least 15 days prior to the start of paving operations, must include as a minimum:
- Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percent by weight of each stockpile used in the job mix formula.
- Percent of asphalt binder.
- PG asphalt binder used, and type of modifier, if used.
- Mixing temperature.
- Compaction temperature.
- Temperature of mix when discharged from the mixer.
- Temperature-viscosity relationship of the asphalt binder. If RAP is being used, this shall be for the blend of virgin asphalt and asphalt recovered from the RAP.
- Plot of the combined gradation on the Federal Highway Administration (FHWA) 45 power gradation curve.

- Graphical plots of air voids (Va), voids in the mineral aggregate (VMA), and unit weight, versus asphalt binder content.
- Percent natural sand, if used.
- Percent fractured faces.
- Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).
- Antistrip agent (if required). Contractor shall determine the type and amount of anti-strip agent required in accordance with WSDOT test method T 718.
- Date the job mix formula was developed.

II) JMF Test Submittal. The Contractor must submit to the Engineer [Owner Authorized Representative] the results of verification testing of three (3) asphalt samples prepared at the optimum asphalt content. The average of the results of this testing must indicate conformance with the JMF requirements specified, for criteria listed as follows: Ndes Gyrations, Initial Number of Gyrations [Nini], Maximum Number of Gyrations [Nmax], Air Voids@Ndes [percent], Voids filled with Asphalt @ Ndes [percent], Dust Proportion [percent], Fine Aggregate Angularity, %Gmm@Nini, and %Gmm@Nmax, Tensile Strength Ratio [percent].

5-04.3(8)A1; add: Regardless of tonnage, all airside pavements shall be statistically evaluated, except for small repair work and as indicated on the project plans. If the tonnage is less than 2,500 tons, three sublots will be determined of approximately equal size, for acceptance testing.

5-04.3(8)A5; In the last sentence, change: "and the cost of testing will be the Contracting Agency's responsibility", to: "and the cost of testing will be the Contractor's responsibility at the rate of $250 per challenge sample".

5-04.3(10)B1; In the second sentence; change: "using a minimum of 91.0-percent of the reference maximum density as", to: "using a minimum of 92.0-percent and a maximum of 97.0-percent of the reference maximum density (Gmm) as".

5-04.3(10)B1b; Longitudinal Joint Density; change to: Low joint density is defined as less than 91.0-percent of the reference maximum density (Gmm). And if below 91.0-percent Contractor shall make corrections as approved by the Engineer, or at the Engineer's option a $500 per density lot price adjustment will be assessed for that lot.
A joint lot relates to the pavement lot that crated the joint (the second paving lane of two adjacent paving lanes. One core shall be taken by the Contractor from each sublot. Core locations will be determined by the Engineer on a random basis in accordance with ASTM D 3665. All coring shall be centered on the joint. The minimum core diameter for joint density determination shall be 5 inches.

5-04.3(10)B2; add: Joint Test as part of the Test Strip. Pave two lanes in the test strip and evaluate the longitudinal joint quality. The Test strip needs to demonstrate that the rest of the project (mat and joints) will meet the project specifications. The Joint Test is only required for Airside pavements.

5-04.3(12); For Airside pavements, longitudinal joints shall have offsets with the lower layer of at least 12 inches. Transverse joints in adjacent paving lanes shall be offset a minimum of 10 feet. Areas of segregation, as determined by the Engineer, shall be removed and replaced at the

Contractor's expense. If the Engineer decides to accept the segregated areas, then 5-04.3(10)B1a. Cyclic Density shall apply.
The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.
Longitudinal joints which are irregular, damaged, uncompacted, or otherwise defective (or which have been left exposed for more than 4 hours, or whose surface temperature has cooled to less than 160 F) shall be cut back sufficiently (but no more than 6-inches) to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be cleaned and dry prior and given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The cost of this work and tack coat shall be considered incidental to the cost of the bituminous course.

5-04.3(12)B; delete for Airside pavements: The longitudinal joint in any 1 course shall be offset from the course immediately below by not more than 6-inches nor less than 2-inches.

5-04.3(13); Start this item with:
5-04.3(13A)For Airside pavements, smoothness measurements shall be made transversely at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made along the center of each paving lane. When more than 15 percent of all measurements exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material, when directed by the Engineer. Skin patching shall not be permitted. Isolated high points may be permitted upon the Engineer's approval.

Before 5-04.3(14) insert the following:
5-04.3(13B); **Skid resistant surfaces/saw-cut grooving.** If shown on the plans, skid resistant surfaces for asphalt pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving.
Transverse grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1.5 inches center to center configuration. The grooves shall be continuous for the entire length of the pavement. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for the saw-cut grooves shall meet the following:

a. Alignment tolerance – Plus or minus 1.5 inches in alignment for 75 feet.
b. Groove tolerance – Minimum depth 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch deep. Maximum groove depth is 5/16 inch. Minimum groove width is ¼ inch. Maximum groove width is 5/16 inch.
c. Center to center spacing – Minimum spacing is 1-3/8 inches. Maximum spacing is 1-5/8 inches.

Grooves shall not be less than 6 inches and not more than 18 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. All waste material shall be removed from the pavement surface and disposed of off-site in accordance with governing laws and regulations, and as stated in Division 1 of these WSDOT Standard Specifications (M 41-10). All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

WSDOT Division 9-03.8A;
Aggregate for Hot Mix Asphalt

9-02.1(4); The asphalt binder grade shall be specified as stated in 5-04.2. For Airside pavements accommodating (traffic level B, as defined in 5-04.1A) aircraft with AGW >12,500 lbs (but less than 60,000 lbs) the asphalt binder grade shall be bumped once.
If Reclaimed Asphalt Pavement (RAP) material is recycled into the HMA mixture, the blend of old asphalt (contained in the RAP) and the new asphalt, shall meet the PG grade specified.

9-03.8(2)2.; Regarding the fracture requirements table, change; <10 to Traffic level A, and >10 to Traffic level B.

9-03.8(2)3.; Regarding the uncompacted void content (FAA) table, change; <3 to Traffic level A, and >3 to Traffic level B.

9-03.8(2)4.;
[Note to the Engineer:
WSDOT specifies its mixtures by Class and PG grade. The HMA Class Table refers to the nominal maximum aggregate size NMAS.
In this SSAP this example HMA will therefore be specified as follows: "½ In NMAS, PG 64-28".]

9-03.8(2)4.; In the HMA Class Table,

- change: "ESAL's (millions)" to "Traffic Level"; "0.3 to <3" to "A and B"; and delete rows; <0.3; 3 to <10; 10 to <30; and >30.

9-03.8(2)4.; In the N(gyrations) Table,

- change: "ESAL's (millions)" to "Traffic Level"; "<0.3" to "A"; "0.3 to <3" to "B"; and delete rows; >3; 3 to <30; and >30.
- For traffic level B change the number of gyrations as follows: 75 becomes 65; and 115 becomes 100.

9-03.8(6); delete the Aggregate Gradation Control Points table, and replace it with the Table – Aggregate Gradation as shown below.

[Note to the Engineer:
The aggregate gradations must be specified from the Aggregate Gradation Table below. The gradations are defined by nominal maximum aggregate size (NMAS), which is one sieve size larger than the first sieve to retain more than 10 percent. Generally, the NMAS is one sieve size smaller than the maximum aggregate size (MAS). The aggregate gradations below are representative of the NMAS Superpave mixtures with gradations requirements based on control points established by AASHTO M 323. The combined aggregate gradation shall be known as coarse-graded when it passes below the Primary Control Sieve (PCS) control point as defined in AASHTO M 323. All other gradations shall be referred to as fine-graded. For both Traffic Level A and B surface courses, the fine-graded aggregate gradation has demonstrated excellent performance for HMA airport pavements and should be preferred.
For airport pavement surface courses, the Superpave 1/2 -inch (12.5 mm) NMAS aggregate gradation is commonly specified. For leveling, intermediate, and base courses, the Superpave NMAS aggregate sizes from the Aggregate Gradation Table below should be specified respectively, at the discretion of the design engineer, and with the NMAS to lift thickness ratio of 3 to 4 in mind.]

Table - Aggregate Gradation, After FAA Item P-401(SP) and AASHTO M 323.

Sieve Size	All Pavements				
	Percent by Weight Passing Sieves				
	1 1/2 in NMAS (37.5 mm) Control Points	1.0 in. NMAS (25.0 mm) Control Points	3/4 in NMAS (19 mm) Control Points	1/2 in NMAS (12.5 mm) Control Points	3/8 in NMAS (9.5 mm) Control Points
1.5 in (50.0 mm)	100				
1.25 in (37.5 mm)	90 to 100	100			
1.0 in.(25.0 mm)	90 maximum	90 to 100	100		
¾ in.(19.0 mm)		90 maximum	90 to 100	100	
½ in.(12.5 mm)			90 maximum	90 to 100	100
⅜ in.(9.5 mm)				90 maximum	90 to 100
No. 4(4.75 mm)					90 maximum
No. 8(2.36 mm)	15 to 41	19 to 45	23 to 49	28 to 58	32 to 67
No. 16(1.18 mm)					
No. 30(0.600 mm)					
No. 50 (0.300 mm)					
No. 100(0.150 mm)					
No. 200 (0.075 mm)	0 to 6	1 to 7	2 to 8	2 to 10	2 to 10

END

APPENDIX I2

WSDOT Division 5-04
Hot Mix Asphalt

and

WSDOT Division 9-03.8
Aggregate for Hot Mix Asphalt

5-04 HOT MIX ASPHALT

5-04.1 Description

This Work shall consist of providing and placing 1 or more layers of plant-mixed hot mix asphalt (HMA) on a prepared foundation or base in accordance with these Specifications and the lines, grades, thicknesses, and typical cross-sections shown in the Plans.

HMA shall be composed of asphalt binder and mineral materials as may be required, mixed in the proportions specified to provide a homogeneous, stable, and workable mixture.

5-04.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt Binder	9-02.1(4)
Cationic Emulsified Asphalt	9-02.1(6)
Anti-Stripping Additive	9-02.4
Aggregates	9-03.8
Blending Sand	-03.8(4)
Mineral Filler	9-03.8(5)
Recycled Material	9-03.21

The Contract documents may establish that the various mineral materials required for the manufacture of HMA will be furnished in whole or in part by the Contracting Agency. If the documents do not establish the furnishing of any of these mineral materials by the Contracting Agency, the Contractor shall be required to furnish such materials in the amounts required for the designated mix. Mineral materials include coarse and fine aggregates, blending sand, and mineral filler.

The Contractor may choose to utilize recycled asphalt pavement (RAP) in the production of HMA. If utilized, the amount of RAP shall not exceed 20-percent of the total weight of aggregate in the mix. The RAP may be from pavements removed under the Contract, if any, or pavement material from an existing stockpile.

The grade of asphalt binder shall be as required by the Contract. Prior to the submittal of the mix design, the Contractor shall provide a written designation of the grade of PG asphalt binder to be used. The Contractor may propose the substitution of alternate grades of performance grade (PG) asphalt binder at no cost to the Contracting Agency. The proposal will be approved if the proposed alternate asphalt binder has an average 7-day maximum pavement design temperature that is equal to or higher than the specified asphalt binder and has a minimum pavement design temperature that is equal to or lower than the specified asphalt binder. The substituted alternate grade of asphalt binder shall be used in all HMA Contract items of the same class and originally specified grade of asphalt binder. Blending of asphalt binder from different sources is not permitted.

When the Contracting Agency provides aggregates or provides a source for the production of aggregates, the Contract Provisions will establish the approximate percentage of asphalt binder required in the mixture for each class of pavement.

Production of aggregates shall comply with the requirements of 3-.

Preparation of stockpile site, the stockpiling of aggregates, and the removal of aggregates from stockpiles shall comply with the requirements of 3-.

5-04.3 Construction Requirements

5-04.3(1) HMA Mixing Plant

Plants used for the preparation of HMA shall conform to the following requirements:

1. **for Preparation of Asphalt Binder.** Tanks for the storage of asphalt binder shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the storage tank. The circulating system for the asphalt binder shall be designed to ensure proper and continuous circulation during the operating period. A valve for the purpose of sampling the asphalt binder shall be placed in either the storage tank or in the supply line to the mixer.
2. **Thermometric Equipment.** An armored thermometer, capable of detecting temperature ranges expected in the HMA mix, shall be fixed in the asphalt binder feed line at a location near the charging valve at the mixer unit. The thermometer location shall be convenient and safe for access by Inspectors.

   The plant shall also be equipped with an approved dial-scale thermometer, a mercury actuated thermometer, an electric pyrometer, or another approved thermometric instrument placed at the discharge chute of the drier to automatically register or indicate the temperature of the heated aggregates. This device shall be in full view of the plant operator.
3. **Sampling and Testing of Mineral Materials.** The HMA plant shall be equipped with a mechanical sampler for the sampling of the mineral materials. The mechanical sampler shall meet the requirements of 1-05. for the crushing and screening operation.

The Contractor shall provide sufficient space as required for the setup and operation of the field testing facilities of the Contracting Agency.

4. Sampling HMA. The HMA plant shall provide for sampling HMA by one of the following methods:
    a. A mechanical sampling device attached to the HMA plant.
    b. Platforms or devices to enable sampling from the hauling vehicle without entering the hauling vehicle.

5-04.3(2) Hauling Equipment

Trucks used for hauling HMA shall have tight, clean, smooth metal beds and shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from adverse weather. Whenever the weather conditions during the workshift include, or are forecast to include, precipitation or an air temperature less than 45°F, the cover shall be securely attached to protect the HMA.

In order to prevent the HMA mixture from adhering to the hauling equipment, truck beds are to be sprayed with an environmentally benign release agent. Excess release agent shall be drained prior to filling hauling equipment with HMA. Petroleum derivatives or other coating material that contaminate or alter the characteristics of the HMA shall not be used. For hopper trucks, the conveyer shall be in operation during the process of applying the release agent.

5-04.3(3) Hot Mix Asphalt Pavers

HMA pavers shall be self-contained, power-propelled units, provided with an internally heated vibratory screed and shall be capable of spreading and finishing courses of HMA plant mix material in lane widths required by the paving section shown in the Plans.

The screed shall be operated in accordance with the manufacturer's recommendations and shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating, or gouging the mixture. A copy of the manufacturer's recommendations shall be provided upon request by the Contracting Agency. Extensions will be allowed provided they produce the same results, including ride, density, and surface texture as obtained by the primary screed. Extensions without augers and an internally heated vibratory screed shall not be used in the Traveled Way.

When laying HMA, the paver shall be operated at a uniform forward speed consistent with the plant production rate and roller train capacity to result in a continuous operation. The auger speed and flight gate opening shall be adjusted to coordinate with the operation.

The paver shall be equipped with automatic screed controls with sensors for either or both sides of the paver. The controls shall be capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing automatic signals that operate the screed to maintain the desired grade and transverse slope. The sensor shall be constructed so it will operate from a reference line or a mat referencing device.

The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1-percent. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

Manual operation of the screed will be permitted in the construction of irregularly shaped and minor areas. These areas include, but are not limited to, gore areas, road approaches, tapers and left-turn channelizations.

When specified in the Contract, reference lines for vertical control will be required. Lines shall be placed on both outer edges of the Traveled Way of each Roadway. Horizontal control utilizing the reference line will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference lines or by means of a mat referencing device and a slope control device. When the finish of the grade prepared for paving is superior to the established tolerances and when, in the opinion of the Engineer, further improvement to the line, grade, cross-section, and smoothness can best be achieved without the use of the reference line, a mat referencing device may be substituted for the reference line. Substitution of the device will be subject to the continued approval of the Engineer. A joint matcher may be used subject to the approval of the Engineer. The reference line may be removed after the completion of the first course of HMA when approved by the Engineer. Whenever the Engineer determines that any of these methods are failing to provide the necessary vertical control, the reference lines will be reinstalled by the Contractor.

The Contractor shall furnish and install all pins, brackets, tensioning devices, wire, and accessories necessary for satisfactory operation of the automatic control equipment.

If the paving machine in use is not providing the required finish, the Project Engineer may suspend Work as allowed by 1-08.. Any cleaning or solvent type liquids spilled on the pavement shall be thoroughly removed before paving proceeds.

5-04.3(4) Rollers

Rollers shall be of the steel wheel, vibratory, or pneumatic tire type, in good condition and capable of reversing without backlash. Operation of the roller shall be in accordance with the manufacturer's recommendations. When ordered by the Project Engineer for any roller planned for use on the project, the Contractor shall provide a copy of the manufacturer's recommendation for the use of that roller for compaction of HMA. The number and weight of rollers shall be sufficient to compact the mixture in compliance with the requirements of 5-04.3(10). The use of equipment that results in crushing of the aggregate will not be permitted. Rollers producing pickup, washboard, uneven compaction of the surface, displacement of the mixture or other undesirable results shall not be used.

5-04.3(5) Conditioning of Existing Surface

When the surface of the existing pavement or old base is irregular, the Contractor shall bring it to a uniform grade and cross-section as shown on the Plans or approved by the Engineer.

Preleveling of uneven or broken surfaces over which HMA is to be placed may be accomplished by using an asphalt paver, a motor patrol grader, or by hand raking, as approved by the Engineer.

5-04.3(5)A Preparation of Existing Surfaces

Before construction of HMA on an existing paved surface, the entire surface of the pavement shall be clean. All fatty asphalt patches, grease drippings, and other objectionable matter shall be entirely removed from the existing pavement. All pavements or bituminous surfaces shall be thoroughly cleaned of dust, soil, pavement grindings, and other foreign matter. All holes and small depressions shall be filled with an appropriate class of HMA. The surface of the patched area shall be leveled and compacted thoroughly.

A tack coat of asphalt shall be applied to all paved surfaces on which any course of HMA is to be placed or abutted. Tack coat shall be uniformly applied to cover the existing pavement with a thin film of residual asphalt free of streaks and bare spots. A heavy application of tack coat will be applied to all joints. For Roadways open to traffic, the application of tack coat shall be limited to surfaces that will be paved during the same working shift. The spreading equipment shall be equipped with a thermometer to indicate the temperature of the tack coat material.

Equipment shall not operate on tacked surfaces until the tack has broken and cured. If the Contractor's operation damages the tack coat it shall be repaired prior to placement of the HMA.

Unless otherwise approved by the Engineer, the tack coat shall be CSS-1, CSS-1h, or STE-1 emulsified asphalt. The CSS-1 and CSS-1h emulsified asphalt may be diluted with water at a rate not to exceed 1-part water to 1-part emulsified asphalt. The tack coat shall not exceed the maximum temperature recommended by the emulsified asphalt manufacturer.

5-04.3(5)B Preparation of Untreated Roadway

When designated in the Plans the existing Roadway shall be prepared and primed. The Roadway preparation shall be performed in accordance with the Bituminous Surface Treatment provisions for this type of Work (5-02.3(2)), except that only one application of asphalt and one application of aggregate shall be applied. The aggregate shall conform either to the requirements of Section -03., -03. or shall consist of other material approved by the Engineer. All other provisions of 5- pertaining to New Construction bituminous surface treatments shall apply to this preparation Work, except as hereinafter modified.

The prime coat shall be applied over the full length of the project. HMA shall not be placed until the prime coat has cured for 5-days unless otherwise approved by the Engineer.

Should any holes, breaks, or irregularities develop in the Roadway surface after the prime coat has been applied, they shall be patched, as described in 5-04.3(5), before placement of the HMA pavement. The Contractor shall maintain the completed prime coat by blading or brooming with equipment and procedures approved by the Engineer, until the HMA pavement is placed.

After the maintenance, patching or repair Work has been completed and immediately prior to placing the HMA, the surface of the prime coat shall be swept clean of all dirt, dust, or other foreign matter.

When the prime coat application is not specified in the Special Provisions or shown in the Plans, the Contractor shall prepare the untreated Roadway as described above and shall omit the prime coat treatment. The HMA shall be constructed on the prepared Subgrade.

The Contractor shall prepare untreated Shoulders and traffic islands by blading and compacting to provide a sound base for paving and shall omit the prime coat treatment. The HMA shall be constructed on the prepared Subgrade.

5-04.3(5)C Crack Sealing

When the Proposal includes a pay item for crack sealing, all cracks and joints ¼-inch and greater in width shall be cleaned with a stiff-bristled broom and compressed air and then shall be filled completely with sand slurry.

The sand slurry shall consist of approximately 20-percent CSS-1 emulsified asphalt, approximately 2-percent Portland cement, water (if required), and the remainder clean U.S. No. 4-0 paving sand. The components shall be thoroughly mixed and then poured into the cracks and joints until full. The following day, any cracks or joints that are not completely filled shall be topped off with additional sand slurry. After the sand slurry is placed, the filler shall be struck off flush with the existing pavement surface and allowed to cure. The HMA overlay shall not be placed until the slurry has fully cured. The requirements of 1- will not apply to the Portland cement and paving sand used in the sand slurry.

5-04.3(5)D Soil Residual Herbicide

Where shown in the Plans, the Contractor shall apply one application of an approved soil residual herbicide. The requirements of 8-02.3(2) shall apply to this application. Paving shall begin within 24-hours after application of the herbicide.

The material to be used shall be registered with the Washington State Department of Agriculture for use under pavement. Before use, the Contractor shall obtain approval of the material to be used and the proposed rate of application from the Project Engineer. The following information shall be included in the request for approval of the material:

1. Brand Name of the Material;
2. Manufacturer;
3. Environmental Protection Agency (EPA) Registration Number;
4. Material Safety Data Sheet; and
5. Proposed Rate of Application.

5-04.3(5)E Pavement Repair

The Contractor shall excavate pavement repair areas and shall backfill these with HMA in accordance with the details shown in the Plans and as staked.

The Project Engineer will determine the excavation depth, which may vary up to 1-foot. The determination will depend on the location of material suitable for support of the pavement.

The minimum width of any pavement repair area shall be 3-feet unless shown otherwise in the Plans. Before any excavation, the existing pavement shall be sawcut or shall be removed by a pavement grinder.

Asphalt for tack coat shall be required as specified in 5-04.3(5). A heavy application of tack coat shall be applied to all surfaces of existing pavement in the pavement repair area.

The Contractor shall excavate only within one lane at a time unless approved otherwise by the Project Engineer. Any repair areas started during a workshift shall be completed during the same workshift. The Contractor shall not excavate more area than can be completely finished during the same shift.

Excavated materials will become the property of the Contractor and shall be disposed in a Contractor-provided site off the Right of Way or used in accordance with Sections -02.3(3) or -03..

The Contractor shall conduct the excavation operations in a manner that will protect the pavement that is to remain. Pavement not designated to be removed that is damaged as a result of the Contractor’s operations shall be repaired by the Contractor to the satisfaction of the Project Engineer at no cost to the Contracting Agency.

Placement of the HMA backfill shall be accomplished in lifts not to exceed 0.35-foot compacted depth. Each lift shall be thoroughly compacted by a mechanical tamper or a roller.

5-04.3(6) Heating of Asphalt Binder

The temperature of the asphalt binder shall not exceed the maximum recommended by the asphalt binder manufacturer. The asphalt binder shall be heated in a manner that will avoid local variations in heating. The heating method shall provide a continuous supply of asphalt binder to the mixer at a uniform average temperature with no individual variations exceeding 25°F.

5-04.3(7) Preparation of Aggregates

The aggregates shall be stockpiled according to the requirements of 3-. Sufficient storage space shall be provided for each size of aggregate. The aggregates shall be removed from stockpile(s) in a manner to ensure a minimum of segregation when being moved to the HMA plant for processing into the final mixture. Different aggregate sizes shall be kept separated until they have been delivered to the HMA plant.

5-04.3(7)A Mix Design

1. **General.** Prior to the production of HMA, the Contractor shall determine a design aggregate structure and asphalt binder content in accordance with WSDOT Standard Operating Procedure 732. Once the design aggregate structure and asphalt binder content have been determined, the Contractor shall submit the HMA mix design on DOT form 350-042 demonstrating that the design meets the requirements of Sections -03.8(2) and -03.8(6). For HMA accepted by commercial evaluation only the first page of DOT form 350-042 and the percent of asphalt binder is required. In no case shall the paving begin before the determination of anti-strip requirements has been made.

   Changes to the aggregate or asphalt binder require approval of the Engineer and may require a new mix design submittal from the Contractor. For aggregate this will include changes in the source of material or a change in the percentage of material from a stockpile greater than 5 precent. Asphalt binder changes include the source of the crude petroleum supplied to the refinery, the refining process and additives or modifiers in the asphalt binder. For mix designs that will be used in more than one calendar year and have not changed the Contractor shall submit a certification that the mix design has not changed.

2. **Statistical or Nonstatistical Evaluation.** When the Contract calls for either of these evaluation methods, the Contractor shall submit representative samples of the mineral materials that are to be used in the HMA production. The Contracting Agency will use these samples to determine anti-strip requirements, if any, in accordance with WSDOT test method T 718 and will also conduct verification testing of the mix design. Verification testing of HMA mix designs proposed by the Contractor that include RAP will be completed without the inclusion of the RAP. Submittal of RAP samples is not required. A mix design verification report will be provided within 25-calendar days after a mix design submittal has been received in the State Materials Laboratory in Tumwater.

   If the results of the verification testing of the mix design by the Contracting Agency are within the tolerances in 9-03.8(7) the mix design will be considered verified. HMA requiring nonstatistical evaluation must have a verified mix design before paving will be allowed. Where HMA requires statistical evaluation, and where the mix design did not meet the required tolerances to be verified, the Contractor shall have the option to either resubmit a new mix design or proceed to paving the HMA mixture test section.

   The mix design will be the initial job mix formula (JMF) for the class of mix. Any additional adjustments to the JMF will require the approval of the Project Engineer and may be made per 9-03.8(7).
3. **Commercial Evaluation.** Verification of the mix design by the Contracting Agency is not required. The Project Engineer will determine anti-strip requirements for the HMA. For commercial HMA, the Contractor shall select a class of HMA and design level of Equivalent Single Axle Loads (ESAL's) appropriate for the required use.

5-04.3(8) Mixing

After the required amounts of mineral materials and asphalt binder have been introduced into the mixer the HMA shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt binder throughout the mineral materials is ensured.

When discharged, the temperature of the HMA shall not exceed the maximum temperature recommended by the asphalt binder manufacturer. A maximum water content of 2-percent in the mix, at discharge, will be allowed providing the water causes no problems with handling, stripping, or flushing. If the water in the HMA causes any of these problems, the moisture content shall be reduced as directed by the Project Engineer.

Storing or holding of the HMA in approved storage facilities will be permitted during the daily operation but in no event shall the HMA be held for more than 24-hours. HMA held for more than 24-hours after mixing shall be rejected. Rejected HMA shall be disposed of by the Contractor at no expense to the Contracting Agency. The storage facility shall have an accessible device located at the top of the cone or about the third point. The device shall indicate the amount of material in storage. No HMA shall be accepted from the storage facility when the HMA in storage is below the top of the cone of the storage facility, except as the storage facility is being emptied at the end of the working shift.

5-04.3(8)A Acceptance Sampling and Testing—HMA Mixture

1. **General.** Acceptance of HMA shall be as provided under statistical, nonstatistical or commercial evaluation.

   Acceptance of HMA by statistical evaluation is administered under the provisions of 5-04.5(1) Quality Assurance Price Adjustments. Statistical evaluation will be used for a class of HMA when the Proposal quantities for that class of HMA exceed 2,500-tons.

   Nonstatistical evaluation will be used for the acceptance of HMA when the Proposal quantities for a class of HMA are 2,500-tons or less.

   Commercial evaluation will be used for Commercial HMA and for other classes of HMA in the following applications: sidewalks, road approaches, ditches, slopes, paths, trails, gores, prelevel, and pavement repair. Other nonstructural applications of HMA accepted by commercial evaluation shall be as approved by the Project Engineer. Sampling and testing of HMA accepted by commercial evaluation will be at the option of the Project Engineer. The Proposal quantity of HMA that is accepted by commercial evaluation will be excluded from the quantities used in the determination of statistical and nonstatistical evaluation.
2. **Aggregates.** For HMA under statistical evaluation the gradation of aggregates will be included in the statistical calculations. The acceptance criteria for aggregate properties of sand equivalent, uncompacted void content and fracture will be their conformance to the requirements of 9-03.8(2). These properties will not be included in the statistical evaluation.
3. **Sampling.** Samples for acceptance testing shall be obtained by the Contractor when ordered by the Engineer. The Contractor shall sample the HMA mixture in the presence of the Engineer and in accordance with WSDOT FOP for WAQTC/AASHTO T 168.
4. **Definition of Sampling Lot and Sublot.** For the purpose of acceptance sampling and testing, a lot is defined as the total quantity of material or Work produced for each job mix formula (JMF) placed. A lot is represented by randomly selected samples that will be tested for acceptance. All of the test results obtained from the acceptance samples from a given lot shall be evaluated collectively. Only one lot per mix design will be expected to occur. The initial JMF is defined in 5-04.3(7) Mix Design. The Contractor may request

a change in the JMF in accordance with 9-03.8(7). If the request is approved, all of the material produced up to the time of the change will be evaluated on the basis of tests on samples taken from that material and a new lot will begin.

Sampling and testing for statistical evaluation shall be performed on a random basis. The sublot size shall be determined to provide not less than three uniform-sized sublots with a maximum sublot size of 800-tons. Should a lot contain fewer than three sublots, the HMA will be accepted in accordance with nonstatistical evaluation.

Sampling and testing for nonstatistical evaluation shall be performed on the frequency of one sample per sublot. The sublots shall be approximately uniform in size with a maximum sublot size of 800-tons.

The quantity of material represented by the final sublot for either statistical or nonstatistical evaluation may be increased to a maximum of 2-times the sublot quantity calculated.

5. **Test Results.** The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed in the field at the beginning of the next paving shift. The Engineer will also provide the Composite Pay Factor (CPF) of the completed sublots after three sublots have been produced. The CPF will be provided by the midpoint of the next paving shift after sampling.

   Sublot sample test results (gradation and asphalt binder content) may be challenged by the Contractor. For HMA mixture accepted by statistical evaluation with a mix design that did not meet the verification tolerances, the test results in the test section including the percent air voids (Va) may be challenged. To challenge test results, the Contractor shall submit a written challenge within 7-calendar days after receipt of the specific test results. A split of the original acceptance sample will be sent for testing to either the Region Materials Laboratory or the State Materials Laboratory as determined by the Project Engineer. The split of the sample with challenged results will not be tested with the same equipment or by the same tester that ran the original acceptance test. The challenge sample will be tested for a complete gradation analysis and for asphalt binder content.

   The results of the challenge sample will be compared to the original results of the acceptance sample test and evaluated according to the following criteria:

Deviation	
U.S. No. 4 sieve and larger	Percent passing ±4.0
U.S. No. 8 sieve	Percent passing ±2.0
U.S. No. 200 sieve	Percent passing ±0.4
Asphalt binder	Percent binder content ±0.3
Va Percent	Va ±0.7

   If the results of the challenge sample testing are within the allowable deviation established above for each parameter, the acceptance sample test results will be used for acceptance of the HMA. The cost of testing will be deducted from any monies due or that may come due the Contractor under the Contract at the rate of $250 per challenge sample. If the results of the challenge sample testing are outside of any one parameter established above, the challenge sample will be used for acceptance of the HMA and the cost of testing will be the Contracting Agency's responsibility.

6. **Test Methods.** Testing of HMA for compliance of volumetric properties (VMA, VFA and Va) will be by WSDOT Standard Operating Procedure SOP 731. Testing for compliance of asphalt binder content will be by WSDOT FOP for AASHTO T 308. Testing for compliance of gradation will be by WAQTC FOP for AASHTO T 27/T 11.

7. **Test Section - HMA Mixture.** A mixture test section shall be constructed for every mix design accepted by Statistical Evaluation. The test section shall be used to determine if the mix meets the requirements of Sections -03.8(2) and -03.8(6). The HMA mixture test section may be constructed simultaneously with the compaction test section (5-04.3(10)).

   The test section shall be constructed at the beginning of paving and will be at least 600-tons and a maximum of 800-tons or as approved by the Engineer. No further wearing or leveling HMA will be paved the day of or the day following the construction of the test section. The mixture in the test section will be evaluated as a lot with a minimum of 3 sublots required. If more than 1 test section is required, each test section shall be a separate lot.

   For a test section to be acceptable, with or without a verified mix design, the pay factor (PF) for each of gradation, asphalt binder, VMA and Va shall be 0.95 or greater, and the remaining test requirements in 9-03.8(2) (dust/asphalt ratio, sand equivalent, uncompacted void content and fracture) shall conform to the requirements of that section. When the pay factor for any item is less than 0.95 the Contractor shall make adjustments to the mix in accordance with 9-03.8(7) and construct another test section. The Project Engineer may waive the requirement for the construction of another test section.

For all HMA of the same class and PG asphalt binder grade payment for the HMA in the test section(s) will be in accordance with the provisions of -04.5(1) Quality Assurance Price Adjustments. The CPF for the HMA represented by the first test section shall be a minimum of 0.75 if the mix design was verified by the Contracting agency. The calculation of the CPF in a test section with a verified mix design will include gradation and asphalt binder content. The calculation of the CPF in a test section with a mix design that did not verify will include gradation, asphalt binder content and percent air voids (Va).

5-04.3(9) Spreading and Finishing

The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. HMA pavers complying with 5-04.3(3) shall be used to distribute the mixture. Unless otherwise directed by the Engineer, the nominal compacted depth of any layer of any course shall not exceed the following:

HMA Class 1"	0.35-feet
HMA Class ¾" and HMA Class ½"	0.30-feet
HMA Class ⅜"	0.10-feet

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other equipment or by hand.

When more than 1 JMF is being utilized to produce HMA, the material produced for each JMF shall be placed by separate spreading and compacting equipment. The intermingling of HMA produced from more than 1 JMF is prohibited. Each strip of HMA placed during a work shift shall conform to a single JMF established for the class of HMA specified unless there is a need to make an adjustment in the JMF.

5-04.3(10) Compaction

5-04.3(10)A General

Immediately after the HMA has been spread and struck off, and after surface irregularities have been adjusted, the mix shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, and irregularities and shall conform to the line, grade, and cross-section shown in the Plans. If necessary, the JMF may be altered in accordance with 9-03.8(7) to achieve desired results.

Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any HMA that becomes loose, broken, contaminated, shows an excess or deficiency of asphalt, or is in any way defective, shall be removed and replaced with new hot mix that shall be immediately compacted to conform to the surrounding area.

The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided that the specified densities are attained. An exception shall be that pneumatic tired rollers shall be used between October of any year and April of the following year. Coverages with a vibratory or steel wheel roller may precede pneumatic tired rolling. Unless the Project Engineer has approved otherwise, vibratory rollers shall not be operated in the vibratory mode when the internal temperature of the mix is less than 175°F. Regardless of mix temperature, a vibratory roller shall not be operated in a vibratory mode when checking or cracking of the mat occurs. Vibratory rollers in the vibratory mode are prohibited on bridge decks.

5-04.3(10)B Control

1. **General.** HMA used in traffic lanes, including lanes for ramps, truck climbing, weaving, and speed change, and having a specified compacted course thickness greater than 0.10-foot, shall be compacted to a specified level of relative density. The specified level of relative density shall be a Composite Pay Factor (CPF) of not less than 0.75 when evaluated in accordance with 1-06., using a minimum of 91.0-percent of the reference maximum density as determined by WSDOT FOP for AASHTO T 209. The specified level of density attained will be determined by the statistical evaluation of tests taken in accordance with FOP for WAQTC TM 8 and WSDOT SOP T 729 on the day the mix is placed (after completion of the finish rolling). Each lot will be divided into 5-sublots. The sublot locations within each density lot will be determined by the stratified random sampling procedure conforming to WSDOT Test Method No. 716. The quantity represented by each density lot will be no greater than a single day's production or 400-tons, whichever is less, except the final lot each day may be increased to a maximum of 600-tons.
    a. **Cyclic Density.** The Engineer may also evaluate the HMA for low cyclic density of the pavement in accordance with WSDOT SOP 733. Low cyclic density areas are defined as spots or streaks in the pavement that are less than 89.0-percent of the reference maximum density. If 4 or more low cyclic density areas are identified in a lot, a cyclic density price adjustment will be assessed for that lot. The price adjustment will be calculated as 15 percent of the unit Bid price for the quantity of HMA represented by that lot. Only 1 area per delivered truck and 1 area per delivered trailer of HMA will be counted toward the number of low cyclic density areas. Any area tested for density under Section 5-04.3(10)B Control 1. General, will be included in this analysis.

b. **Longitudinal Joint Density.** The Engineer will evaluate the HMA wearing surface for low density at the longitudinal joint in accordance with WSDOT SOP 735. Low density is defined as less than 90.0-percent of the reference maximum density. If 1 density reading, at either longitudinal joint, is below 90.0-percent of the reference maximum density, a $200 per lot price adjustment will be assessed for that lot.

2. **Test Section - Compaction.** For HMA requiring a specified level of relative density a compaction test section may be constructed for each mix design. Prior to the start of paving the Contractor shall notify the PE that a test section is requested and will be constructed.

   The test section, if requested, shall be constructed at the beginning of paving, and shall be done using the equipment and rolling patterns that the Contractor expects to use in the paving operation. The test section will be a maximum of 800-tons. Only 1 test section will be allowed per mix design. When a compaction test section and HMA mixture test section (5-04.3(8)) are both required they may be constructed simultaneously. All of the HMA in the test section shall be evaluated in accordance with -04.3(10). The CPF for compaction for the HMA in a density lot that includes a test section shall be a minimum of 0.75. If a test section is not completed, the HMA will be accepted by statistical evaluation. The Contractor may continue paving operations upon completion of the 800-tons in the test section. HMA placed in excess of 800-tons will be accepted by statistical evaluation. This will require consideration of the presence of the correlation factor for the nuclear density gauge and may require resolution after the correlation factor is known.

3. **Test Results.** The Project Engineer will furnish the Contractor with a copy of the results of all compaction acceptance testing within one working day. Acceptance of HMA compaction will be based on the statistical evaluation and CPF so determined.

   For compaction lots falling below a 1.00 pay factor and thus subject to price reduction or rejection, the Contractor may request that cores be used for acceptance of HMA compaction. When cores are taken by the Contracting Agency at the request of the Contractor, they shall be requested by noon of the next workday after receiving the test results. The cores will be taken at approximately the same locations as the nuclear density gauge tests in the compaction lot being challenged. When the CPF for the lot based on the results of the HMA cores is less than 1.00, the cost for the coring will be deducted from any monies due or that may become due the Contractor under the Contract at the rate of $125 per core.

HMA constructed under conditions other than those listed above in paragraph “1. General” shall be compacted on the basis of a test point evaluation of the compaction train. The test point evaluation shall be performed in accordance with instructions from the Project Engineer. The number of passes with an approved compaction train, required to attain the maximum test point density, shall be used on all subsequent paving.

HMA for preleveling shall be thoroughly compacted. HMA that is used for preleveling wheel rutting shall be compacted with a pneumatic tire roller unless otherwise approved by the Engineer.

5-04.3(11) Reject HMA

1. **Rejection by Contractor.** The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material. Any such new material will be sampled, tested, and evaluated for acceptance.

2. **Rejection Without Testing.** The Project Engineer may, without sampling, reject any batch, load, or section of Roadway that appears defective in gradation or asphalt binder content. Material rejected before placement shall not be incorporated into the pavement. Any rejected section of Roadway shall be removed.

   No payment will be made for the rejected materials or the removal of the materials unless the Contractor requests that the rejected material be tested. If the Contractor elects to have the rejected material tested, a minimum of 3 representative samples will be obtained and tested. Acceptance of rejected material will be based on conformance with the statistical acceptance Specification. If the CPF for the rejected material is less than 0.75, no payment will be made for the rejected material, and in addition, the cost of sampling and testing shall be borne by the Contractor. However, if the CPF is greater than or equal to 0.75, the cost of sampling and testing will be borne by the Contracting Agency and the mix will be compensated at a CPF of 0.75. If rejection occurs after placement and the CPF is greater than 0.75, compensation for the rejected mix will be at the calculated CPF with an addition of 25-percent of the unit Contract price added for the cost of removal and disposal.

3. **A Partial Sublot.** In addition to the random acceptance sampling and testing, the Project Engineer may also isolate from a normal sublot any material that is suspected of being defective in relative density, gradation or asphalt binder content. Such isolated material will not include an original sample location. A minimum of 3 random samples of the suspect material will be obtained and tested. The material will then be statistically evaluated as an independent lot in accordance with 1-06.2(2).

4. **An Entire Sublot.** An entire sublot that is suspected of being defective may be rejected. When a sublot is rejected a minimum of 2 additional random samples from this sublot will be obtained. These additional samples and the original sublot will be evaluated as an independent lot in accordance with 1-06.2(2).

5. **A Lot in Progress.** The Contractor shall shut down operations and shall not resume HMA placement until such time as the Project Engineer is satisfied that material conforming to the Specifications can be produced:
   a. When the Composite Pay Factor (CPF) of a lot in progress drops below 1.00 and the Contractor is taking no corrective action, or
   b. When the Pay Factor (PF) for any constituent of a lot in progress drops below 0.95 and the Contractor is taking no corrective action, or
   c. When either the for any constituent or the CPF of a lot in progress is less than 0.75.
6. **An Entire Lot.** An entire lot with a CPF of less than 0.75 will be rejected. The designated percentage reduction as defined in 1-06.2(2) under Financial Incentive Paragraph 1, Item 3, shall be 25-percent.

5-04.3(12) Joints

5-04.3(12)A Transverse Joints

The Contractor shall conduct operations such that the placing of the top or wearing course is a continuous operation or as close to continuous as possible. Unscheduled transverse joints will be allowed and the roller may pass over the unprotected end of the freshly laid mixture only when the placement of the course must be discontinued for such a length of time that the mixture will cool below compaction temperature. When the Work is resumed, the previously compacted mixture shall be cut back to produce a slightly beveled edge for the full thickness of the course.

A temporary wedge of HMA constructed on a 50H:1V shall be constructed where a transverse joint is open to traffic. The HMA in the temporary wedge shall be separated from the permanent HMA by strips of heavy wrapping paper. The wrapping paper shall be removed and the joint trimmed to a slightly beveled edge for the full thickness of the course prior to resumption of paving.

The material that is cut away shall be wasted and new mix shall be laid against the cut. Rollers or tamping irons shall be used to seal the joint.

5-04.3(12)B Longitudinal Joints

The longitudinal joint in any 1 course shall be offset from the course immediately below by not more than 6-inches nor less than 2-inches. All longitudinal joints constructed in the wearing course shall be located at a lane line or an edge line of the Traveled Way. Except, on one-lane ramps a longitudinal joint may be constructed at the center of the traffic lane, subject to approval by the Project Engineer, if:

1. The ramp must remain open to traffic, or
2. The ramp is closed to traffic and a hot-lap joint is constructed.

   If a hot-lap joint is allowed, 2 paving machines shall be used; a minimum compacted density in accordance with 5-04.3(10) shall be achieved throughout the traffic lane; and construction equipment other than rollers shall not operate on any uncompacted mix.

When HMA is placed adjacent to cement concrete pavement, the Contractor shall construct longitudinal joints between the HMA and the cement concrete pavement. The joint shall be sawed to the dimensions shown on Standard Plan A-1 and filled with joint sealant meeting the requirements of 9-04..

5-04.3(13) Surface Smoothness

The completed surface of all courses shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The completed surface of the wearing course shall not vary more than ⅛-inch from the lower edge of a 10-foot straightedge placed on the surface parallel to the centerline. The transverse slope of the completed surface of the wearing course shall vary not more than ¼-inch in 10-feet from the rate of transverse slope shown in the Plans.

When deviations in excess of the above tolerances are found that result from a high place in the HMA, the pavement surface shall be corrected by one of the following methods:

1. Removal of material from high places by grinding with an approved grinding machine, or
2. Removal and replacement of the wearing course of HMA, or
3. By other method approved by the Project Engineer.

Correction of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances.

Deviations in excess of the above tolerances that result from a low place in the HMA and deviations resulting from a high place where corrective action, in the opinion of the Project Engineer, will not produce satisfactory results will be accepted with a price adjustment. The Project Engineer shall deduct from monies due or that may become due to the Contractor the sum of $500.00 for each and every section of single traffic lane 100-feet in length in which any excessive deviations described above are found.

When Portland cement concrete pavement is to be placed on HMA, the surface tolerance of the HMA shall be such that no surface elevation lies above the Plan grade minus the specified Plan depth of Portland cement concrete pavement. Prior to placing the Portland cement concrete pavement, any such irregularities shall be brought to the required tolerance by grinding or other means approved by the Project Engineer.

When utility appurtenances such as manhole covers and valve boxes are located in the Traveled Way, the Roadway shall be paved before the utility appurtenances are adjusted to the finished grade.

5-04.3(14) Planing Bituminous Pavement

Planing shall be performed in such a manner that the underlying pavement is not torn, broken, or otherwise damaged by the planing operation. Delamination or raveling of the underlying pavement will not be construed as damage due to the Contractor's operations. Pavement outside the limits shown in the Plans or designated by the Engineer that is damaged by the Contractor's operations shall be repaired to the satisfaction of the Engineer, at the Contractor's expense.

For mainline planing operations, the equipment shall have automatic controls, with sensors for either or both sides of the equipment. The controls shall be capable of sensing the grade from an outside reference line, or a mat-referencing device. The automatic controls shall have a transverse slope controller capable of maintaining the mandrel at the desired transverse slope (expressed as a percentage) within plus or minus 0.1-percent.

The planings and other debris resulting from the planing operation shall become the property of the Contractor and be disposed of in accordance with Section -03.3(7). The planings may be utilized as RAP, within the requirements of Section -04. or -03..

5-04.3(15) HMA Road Approaches

HMA approaches shall be constructed at the locations shown in the Plans or where staked by the Project Engineer. The Work shall be performed in accordance with 5-.

5-04.3(16) Weather Limitations

HMA for wearing course shall not be placed on any Traveled Way between October 1 of any year and April 1 of the following year without written approval from the Project Engineer.

Asphalt for prime coat shall not be applied when the ground temperature is lower than 50°F without written approval of the Project Engineer.

HMA shall not be placed on any wet surface, or when the average surface temperatures are less than those specified in the following table, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

Surface Temperature Limitation		
Compacted Thickness (Feet)	**Wearing Course**	**Other Courses**
Less than 0.10	55°F	45°F
0.10 to 0.20	45°F	35°F
0.21 to 0.35	35°F	35°F
More than 0.35	(Not Applicable)	25ºF*

*Only on dry Subgrade, not frozen and when air temperature is rising.

5-04.3(17) Paving Under Traffic

When the Roadway being paved is open to traffic, the requirements of this section shall apply.

The Contractor shall keep on-ramps and off-ramps open to traffic at all times except when paving the ramp or paving across the ramp. During such time, and provided that there has been an advance warning to the public, the ramp may be closed for the minimum time required to place and compact the mixture. In hot weather, the Project Engineer may require the application of water to the pavement to accelerate the finish rolling of the pavement and to shorten the time required before reopening to traffic.

Before closing a ramp, advance warning signs shall be placed and signs shall also be placed marking the detour or alternate route. Ramps shall not be closed on consecutive interchanges at the same time.

During paving operations, temporary pavement markings shall be maintained throughout the project. Temporary pavement markings shall be installed on the Roadway prior to opening to traffic. Temporary pavement markings shall be in accordance with 8-.

All costs in connection with performing the Work in accordance with these requirements, except the cost of temporary pavement markings, shall be included in the unit Contract prices for the various Bid items involved in the Contract.

5-04.3(18) Vacant

5-04.3(19) Sealing of Pavement Surfaces

Where shown in the Plans, the Contractor shall apply a fog seal. Before application of the fog seal all surfaces shall be thoroughly cleaned of dust, soil, pavement grindings, and other foreign matter. The fog seal shall be CSS-1 or CSS-1h emulsified asphalt uniformly applied to the pavement. The finished application shall be free of streaks and bare spots. The emulsified asphalt shall be diluted at a rate of 1-part water to 1-part emulsified asphalt unless otherwise directed by the Project Engineer. The diluted emulsified asphalt shall be applied at the rate of 0.10 to 0.18 (0.03 to 0.05 residual) gallons per square yard. The emulsified asphalt shall be applied within the temperature range specified for these asphalt emulsions in 5-02.3(3). Unless otherwise approved by the Project Engineer, the fog seal shall be applied prior to opening to traffic.

5-04.3(20) Anti-Stripping Additive

When directed by the Project Engineer, an anti-stripping additive shall be added to the HMA in accordance with 9-02..

5-04.3(21) Asphalt Binder Revision

When the Contracting Agency provides a source of aggregate, the expected percentage content of new asphalt binder in the resulting mix will be identified in the Contract documents.

Should the actual percentage of new asphalt binder required by the job mix formula for asphalt concrete produced with Agency-provided aggregate vary by more than plus or minus 0.3-percent from the amount shown in the Contract documents, an adjustment in payment will be made. The adjustment in payment (plus or minus) will be based on the invoice cost to the Contractor. No adjustment will be made when the Contractor elects not to use a Contracting Agency-provided source, or when no source is made available by the Contracting Agency.

5-04.4 Measurement

HMA Cl. ___ PG ___, HMA for ___ Cl. ___ PG ___, and Commercial HMA will be measured by the ton in accordance with 1-09., with no deduction being made for the weight of asphalt binder, blending sand, mineral filler, or any other component of the mixture. If the Contractor elects to remove and replace mix as allowed by 5-04.3(11), the material removed will not be measured.

Preparation of Untreated Roadway will be measured by the mile once along the centerline of the main line Roadway. No additional measurement will be made for ramps, Auxiliary Lanes, service roads, Frontage Roads, or Shoulders. Measurement will be to the nearest 0.01-mile.

No specific unit of measure will apply to the force account item of Crack Sealing.

Soil Residual Herbicide will be measured by the mile for the stated width to the nearest 0.01-mile or by the square yard, whichever is designated in the Proposal.

Pavement Repair Excavation will be measured by the square yard of surface marked prior to excavation.

Asphalt for Prime Coat will be measured by the ton in accordance with 1-09..

Prime Coat Aggregate will be measured by the cubic yard, truck measure, or by the ton, whichever is designated in the Proposal.

Asphalt For Fog Seal will be measured by the ton, before dilution, in accordance with 1-09..

Longitudinal Joint Seals between the HMA and cement concrete pavement will be measured by the linear foot along the line and slope of the completed joint seal.

Planing Bituminous Pavement will be measured by the square yard.

Temporary Pavement Marking will be measured by the linear foot as provided in 8-23..

Removing Temporary Pavement Marking will be measured by the linear foot as provided in 8-23..

Water will be measured by the M gallon as provided in 2-07..

No specific unit of measure will apply to the calculated item of Anti-Stripping Additive.

No specific unit of measure will apply to the calculated item of Job Mix Compliance Price Adjustment.

No specific unit of measure will apply to the calculated item of Compaction Price Adjustment.

No specific unit of measure will apply to the calculated item of Cyclic Density Price Adjustment.

No specific unit of measure will apply to the calculated item of Asphalt Binder Revision.

No specific unit of measure will apply to the calculated item of Longitudinal Joint Density Price Adjustment.

5-04.5 Payment

Payment will be made in accordance with 1-04., for each of the following Bid items that are included in the Proposal:

"HMA Cl. ___ PG ___", per ton.

"HMA for Approach Cl. ___ PG ___", per ton.

"HMA for Preleveling Cl. ___ PG ___", per ton.

"HMA for Pavement Repair Cl. ___ PG ___", per ton.

"Commercial HMA", per ton.

The unit Contract price per ton for "HMA Cl. ___ PG ___", "HMA for Approach Cl. ___ PG ___", "HMA for Preleveling Cl. ___ PG ___", "HMA for Pavement Repair Cl. ___ PG ___", and "Commercial HMA" shall be full compensation for all costs incurred to carry out the requirements of 5- except for those costs included in other items which are included in this sub-section and which are included in the Proposal.

"Preparation of Untreated Roadway", per mile.

The unit Contract price per mile for "Preparation of Untreated Roadway" shall be full pay for all Work described under 5-04.3(5), with the exception, however, that all costs involved in patching the Roadway prior to placement of HMA shall be included in the unit Contract price per ton for "HMA Cl. ___ PG ___" which was used for patching. If the Proposal does not include a Bid item for "Preparation of Untreated Roadway", the Roadway shall be prepared as specified, but the Work shall be included in the Contract prices of the other items of Work.

"Crack Sealing", by force account.

"Crack Sealing" will be paid for by force account as specified in 1-09.. For the purpose of providing a common Proposal for all Bidders, the Contracting Agency has entered an amount in the Proposal to become a part of the total Bid by the Contractor.

"Soil Residual Herbicide ____ ft. Wide," per mile, or

"Soil Residual Herbicide", per square yard.

The unit Contract price per mile or per square yard for "Soil Residual Herbicide" shall be full payment for all costs incurred to obtain, provide and install herbicide in accordance with 5-04.3(5).

"Pavement Repair Excavation Incl. Haul", per square yard.

The unit Contract price per square yard for "Pavement Repair Excavation Incl. Haul" shall be full payment for all costs incurred to perform the Work described in 5-04.3(5) with the exception, however, that all costs involved in the placement of HMA shall be included in the unit Contract price per ton for "HMA for Pavement Repair Cl. ___ PG ___", per ton.

"Asphalt for Prime Coat", per ton.

The unit Contract price per ton for "Asphalt for Prime Coat" shall be full payment for all costs incurred to obtain, provide and install the material in accordance with 5-04.3(5).

"Prime Coat Agg.", per cubic yard, or per ton.

The unit Contract price per cubic yard or per ton for "Prime Coat Agg." shall be full pay for furnishing, loading, and hauling aggregate to the place of deposit and spreading the aggregate in the quantities required by the Engineer.

"Asphalt for Fog Seal", per ton.

The unit Contract price per ton for "Asphalt for Fog Seal" shall be full pay for all costs of material, labor, tools, and equipment necessary for the application of the fog seal as specified. If there is no Bid item and a fog seal is required, it shall be applied and the Work shall be included in the unit Contract prices of the other Work items.

"Longitudinal Joint Seal", per linear foot.

The unit Contract price per linear foot for "Longitudinal Joint Seal" shall be full payment for all costs incurred to perform the Work described in 5-04.3(12).

"Planing Bituminous Pavement", per square yard.

The unit Contract price per square yard for "Planing Bituminous Pavement" shall be full payment for all costs incurred to perform the Work described in 5-04.3(14).

"Temporary Pavement Marking", per linear foot.

Payment for "Temporary Pavement Marking" is described in 8-23..

"Removing Temporary Pavement Marking", per linear foot.

Payment for "Removing Temporary Pavement Marking" is described in 8-23..

"Water", per M gallon.

Payment for "Water" is described in 2-07..

"Anti-Stripping Additive", by calculation.

"Anti-Stripping Additive" will be paid for in accordance with 1-09. except that no overhead, profit or other costs shall be allowed. Payment shall be made only for the invoice cost of the additive. The quantity of asphalt binder shall not be reduced by the quantity of anti-stripping additive used. For the purpose of providing a common Proposal for all Bidders, the Contracting Agency has entered an amount in the Proposal to become a part of the total Bid by the Contractor.

"Job Mix Compliance Price Adjustment," by calculation.

"Job Mix Compliance Price Adjustment" will be calculated and paid for as described in 5-04.5(1).

"Compaction Price Adjustment," by calculation.

"Compaction Price Adjustment" will be calculated and paid for as described in 5-04.5(1).

"Cyclic Density Price Adjustment," by calculation.

"Cyclic Density Price Adjustment" will be calculated and paid for as described in 5-04.3(10)B item 1A.

"Asphalt Binder Revision" by calculation.

"Asphalt Binder Revision" will be calculated and paid for as described in 5-04.3(21).

"Longitudinal Joint Density Price Adjustment" by calculation.

"Longitudinal Joint Density Price Adjustment" will be calculated and paid for as described in 5-04.3(10) item 1B.

5-04.5(1) Quality Assurance Price Adjustments

All HMA will be subject to price adjustments. Price adjustments for HMA mixture will be based on the requirements of -04.3(8). Price adjustments for HMA compaction will be based on the requirements in -04.3(10). For the purpose of providing a common Proposal for all Bidders, the Contracting Agency has estimated a calculated amount for all price adjustment items and has entered these amounts in the Proposal to become a part of the total Bid by the Contractor. Statistical analysis of the HMA will be performed in accordance with 1-06..

5-04.5(1)A Price Adjustments for Quality of Mixture

Statistical analysis of quality of gradation and asphalt content will use the following price adjustment factors:

Table of Price Adjustment Factors	
Constituent	**Factor "f"**
All aggregate passing: 1½", 1", ¾", ½", ⅜" and U.S. No.4 sieves	2
All aggregate passing U.S. No. 8 sieve	15
All aggregate passing U.S. No. 200 sieve	20
Asphalt binder	52
Va	30

A pay factor will be calculated for each sieve listed that is equal to or smaller than the maximum allowable aggregate size (100-percent passing sieve) and for the asphalt binder. The "f" factor provided for Va will only be used for the calculation of the pay factor for test section(s) when the mix design was not verified in 5-04.3(7).

1. **Statistical Evaluation.** For each lot of HMA produced under Statistical Evaluation, a Job Mix Compliance Incentive Factor (JMCIF) will be determined. The JMCIF equals the algebraic difference of CPF minus 1.00 multiplied by 60-percent. The Job Mix Compliance Price Adjustment will be calculated as the product of the JMCIF, the quantity of HMA in the lot in tons, and the unit Contract price per ton of mix.
2. **Nonstatistical Evaluation.** Each lot of HMA produced under Nonstatistical Evaluation and having all constituents falling within the tolerance limits of the job mix formula shall be accepted at the unit Contract price with no further evaluation. When one or more constituents fall outside the nonstatistical tolerance limits in 9-03.8(7), the lot shall be evaluated in accordance with 1-06. to determine the appropriate CPF. The nonstatistical tolerance limits will be used in the calculation of the CPF and the maximum CPF shall be 1.00. When less than three sublots exist, backup samples of the existing sublots or samples from the Roadway shall be tested to provide a minimum of three sets of results for evaluation.
3. **Commercial Evaluation.** If sampled and tested, HMA produced under Commercial Evaluation and having all constituents falling within the tolerance limits of the job mix formula shall be accepted at the unit Contract price with no further evaluation. When one or more constituents fall outside the commercial tolerance limits in 9-03.8(7), the lot shall be evaluated in accordance with Section 1-06. to determine the appropriate CPF. The commercial tolerance limits will be used in the calculation of the CPF and the maximum CPF shall be 1.00. When less than three sublots exist, backup samples of the existing sublots or samples from the street shall be tested to provide a minimum of three sets of results for evaluation.

For each lot of HMA produced under Nonstatistical or Commercial Evaluation when the calculated CPF is less than 1.00, a Nonconforming Mix Factor (NCMF) will be determined. The NCMF equals the algebraic difference of CPF minus 1.00 multiplied by 60-percent. The Job Mix Compliance Price Adjustment will be calculated as the product of the NCMF, the quantity of HMA in the lot in tons, and the unit Contract price per ton of mix.

If a constituent is not measured in accordance with these Specifications, its individual pay factor will be considered 1.00 in calculating the Composite Pay Factor (CPF).

5-04.5(1)B Price Adjustments for Quality of HMA Compaction

For each compaction control lot, a Compaction Incentive Price Adjustment Factor (CIPAF) will be determined. The CIPAF equals the algebraic difference of the CPF minus 1.00 multiplied by 40-percent. The Compaction Price Adjustment will be calculated as the product of CIPAF, the quantity of HMA in the compaction control lot in tons, and the unit Contract price per ton of mix.

9-03.8 Aggregates for Hot Mix Asphalt

9-03.8(1) General Requirements

Aggregates for hot mix asphalt shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01. The material from which they are produced shall meet the following test requirements:

Los Angeles Wear, 500 Rev. 30% max.

Degradation Factor, Wearing Course 30 min.

Degradation Factor, Other Courses 20 min.

Aggregates shall be uniform in quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of any size between consecutive laboratory sieves.

Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that the oven dried material retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent by weight of material with a specific gravity less than 1.0.

9-03.8(2) HMA Test Requirements

Aggregate for HMA shall meet the following test requirements:

1. Vacant
2. The fracture requirements for the combined coarse aggregate shall apply to the material retained on the U.S. No. 4 sieve and above, when tested in accordance with FOP for AASHTO TP 61.

ESAL's (millions)	# Fractured Faces	% Fracture
< 10	1 or more	90
≥ 10	2 or more	90

3. The uncompacted void content for the combined fine aggregate is tested in accordance with WSDOT Test Method for AASHTO T 304, Method A. The minimum percent voids shall be as required in the following table:

Traffic	HMA Evaluation	
ESAL's (millions)	Statistical & Nonstiatistical	Commercial
< 3	40	40
≥ 3	44	40

4. The minimum sand equivalent for the aggregate shall be 45.

The mix design shall produce HMA mixtures when combined within the limits set forth in Section 9-03.8(6) and mixed in the laboratory with the designated grade of asphalt binder, using the Superpave gyratory compactor in accordance with WSDOT FOP for AASHTO T 312, and at the required gyrations for N initial, N design, and N maximum with the following properties:

	HMA Class							
	⅜-inch		**½-inch**		**¾-inch**		**1-inch**	
Mix Criteria	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Voids in Mineral Aggregate (VMA), %	15.0		14.0		13.0		12.0	
Voids Filled with Asphalt (VFA), %								
ESAL's (millions)	VFA							
< 0.3	70	80	70	80	70	80	67	80
0.3 to < 3	65	78	65	78	65	78	65	78
3 to < 10	73	76	65	75	65	75	65	75
10 to < 30	73	76	65	75	65	75	65	75
≥ 30	73	76	65	75	65	75	65	75
Dust/Asphalt Ratio	0.6	1.6	0.6	1.6	0.6	1.6	0.6	1.6
Modified Lottman Stripping Test	Pass		Pass		Pass		Pass	

	ESAL's (millions)	**N initial**	**N design**	**N maximum**
% Gmm	< 0.3	≤ 91.5	96.0	≤ 98.0
	0.3 to < 3	≤ 90.5	96.0	≤ 98.0
	≥ 3	≤ 89.0	96.0	≤ 98.0
Gyratory Compaction	< 0.3	6	50	75
(number of gyrations)	0.3 to < 3	7	75	115
	3 to < 30	8	100	160
	≥ 30	9	125	205

The mix criteria VMA and VFA only apply to HMA accepted by statistical evaluation.

When material is being produced and stockpiled for use on a specific contract or for a future contract, the uncompacted void content, fracture, and sand equivalent requirements shall apply at the time of stockpiling. When material is used from a stockpile that has not been tested as provided above, the Specifications for uncompacted void content, fracture, and sand equivalent shall apply at the time of its introduction to the cold feed of the mixing plant.

9-03.8(3) Grading

9-03.8(3)A Gradation

The Contractor may furnish aggregates for use on the same contract from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Section 9-03.8(6).

Acceptance of the aggregate gradation shall be based on samples taken from the final mix.

9-03.8(3)B Gradation — Recycled Asphalt Pavement and Mineral Aggregate

Asphalt concrete planings or old asphalt concrete utilized in the production of HMA shall be sized prior to entering the mixer so that a uniform and thoroughly mixed HMA is produced in the mixer. If there is evidence of the old asphalt concrete not breaking down during the heating and mixing of the HMA, the Engineer may elect to modify the maximum size entering the mixer. No contamination by deleterious materials will be allowed in the old asphalt concrete used.

The gradation for the new aggregate used in the production of the HMA shall be the responsibility of the Contractor, and when combined with recycled material, the combined material shall meet the gradation Specification requirements for the specified Class HMA as listed in Section 9-03.8(6) or as shown in the Special Provisions. The new aggregate shall meet the general requirements listed in Section 9-03.8(1) and Section 9-03.8(2).

9-03.8(4) Blending Sand

Blending sand shall be clean, hard, sound material, either naturally occurring sand or crusher fines, and must be material which will readily accept an asphalt coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Section 9-03.8(6) for the class of material involved. Blending sand shall meet the following quality requirement:

Sand Equivalent 30 Minimum

9-03.8(5) Mineral Filler

Mineral filler, when used in HMA mix, shall conform to the requirements of AASHTO M 17.

9-03.8(6) HMA Proportions of Materials

The materials of which HMA is composed shall be of such sizes, grading, and quantity that, when proportioned and mixed together, they will produce a well graded mixture within the requirements listed below.

The aggregate percentage refers to completed dry mix, and includes mineral filler when used.

Aggregate Gradation Control Points				
Sieve Sizes Percent Passing:	**⅜ In.**	**½ In.**	**¾ In.**	**1 In.**
1½” square				100
1” square			100	90-100
¾” square		100	90-100	90 Maximum
½” square	100	90 - 100	90 Maximum	
⅜” square	90 - 100	90 Maximum		
U.S. No. 4	90 Maximum			
U.S. No. 8	32-67	28-58	23-49	19-45
U.S. No. 200	2.0-7.0	2.0-7.0	2.0-7.0	1.0-7.0

9-03.8(7) HMA Tolerances and Adjustments

1. **Job Mix Formula Tolerances.** The constituents of the mixture at the time of acceptance shall conform to the following tolerances:

	Statistical Evaluation	**Nonstatistical Evaluation**	**Commercial Evaluation**
Aggregate, percent passing			
1”, ¾”, ½” and ⅜” sieves	± 6%	± 6%	± 8%
U.S. No. 4 sieve	± 5%	± 6%	± 8%
U.S. No. 8 sieve	± 4%	± 6%	± 8%
U.S. No. 200 sieve	± 2.0%	± 2.0%	± 3.0%
Asphalt binder	± 0.5%	± 0.5%	± 0.7%

VMA 1.5% below minimum value in Section 9-03.8(2)
VFA minimum and maximum as listed in Section 9-03.8(2)

Va	2.5% minimum and 5.5% maximum

These tolerance limits constitute the allowable limits as described in Section 1-06.2. The tolerance limit for aggregate shall not exceed the limits of the control points, except the tolerance limits for sieves designated as 100% passing will be 99-100. The tolerance limits on sieves shall only apply to sieves with control points. The tolerances for VMA, and Va are for mix design verification and acceptance of the test section. The tolerances for VFA are for mix design verification only. VMA and VFA only apply to HMA accepted by statistical evaluation.

2. Job Mix Formula Adjustments. An adjustment to the aggregate gradation or asphalt binder content of the JMF requires approval of the Project Engineer. Adjustments to the JMF will only be considered if the change produces material of equal or better quality and may require the development of a new mix design if the adjustment exceeds the amounts listed below.

   A. **Aggregates.** The maximum adjustment from the approved mix design shall be 2 percent for the aggregate passing the 1½", 1", ¾", ½", ⅜", and the U.S. No. 4 sieves, 1 percent for aggregate passing the U.S. No. 8 sieve, and 0.5 percent for the aggregate passing the U.S. No. 200 sieve. The adjusted JMF shall be within the range of the control points in Section 9-03.8(6).

   B. **Asphalt Binder Content.** The Project Engineer may order or approve changes to asphalt binder content. The maximum adjustment from the approved mix design for the asphalt binder content shall be 0.3 percent.