Appendix A – VDOT SPECIAL PROVISION

Thin Hot Mix Asphalt Concrete Overlay

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
THIN HOT MIX ASPHALT CONCRETE OVERLAY

June 1, 2007

I. DESCRIPTION

This work shall consist of the production and placement of a thin hot mix asphalt concrete overlay in accordance with the contract requirements, this provision, and as directed by the Engineer.

II. MATERIALS

A. **Asphalt:** The asphalt cement shall be a performance graded asphalt (PG) 70-28 conforming to the requirements of AASHTO Provisional Specification MP-1 and the requirements of Section 210 of the Specifications or as designated by the Engineer

B. **RAP:** Recycled asphalt pavement material will not be permitted.

C. **Coarse aggregate** shall conform to the requirements of Section 203 of the Specifications or as directed by the Engineer. In addition the following requirements shall be met:

Flat and Elongated Particles when tested according to ASTM D 4791 the amount retained on and above the No. 4 sieve shall conform to the following:

3 to 1 Not greater than 25 percent.
5 to 1 Not greater than 10 percent.

Water Absorption when tested according to AASHTO T85 shall be no greater than 2 percent.

D. **Fine aggregate** shall conform to the requirements of Section 202 of the Specifications, except for grading, which shall be tested according to AASHTO TP 33 (Method A) with a value of not less than 45 percent and a sand equivalent value of not less than 50 (AASHTO T 176).

E. **Mineral Filler** shall conform to the requirements of Section 201 of the Specifications.

F. **Fiber Additive** when required shall be cellulose or mineral fiber approved by the Engineer based on supplier's certification of properties and documentation of success in similar applications in hot mix asphalt.

G. **Anti-stripping Additive** shall be hydrated lime at a rate of 1 percent of the total mix or a chemical anti-stripping agent, which has a proven performance in a hot mix asphalt using the same aggregate sources as approved by the Engineer.

III. MIX FORMULA

The Contractor shall submit for the Engineer's approval, a job mix formula within the following design ranges of percent passing each sieve size as noted:

Sieve Size	Percent By Weight Passing Square Mesh Sieves (in)	Production Tolerance (Single Test)
1/2"	100	-2
3/8"	85-100	+/- 5
#4	25-40	+/- 4
#8	19-32	+/- 4
#16	15-23	+/- 3
#30	10-18	+/- 3
#50	8-13	+/- 3
#100	6-10	+/- 2
#200	4-7	+/- 1

Asphalt Content, %	Production Tolerance (Single Test)
5.0 – 5.5*	+/-0.2

*Target asphalt content shall result in a minimum film thickness of 9 microns.

In addition to the job mix submittal, the Contractor shall submit ignition furnace calibration data in accordance with VTM-102 and aggregate property test results prepared by an approved testing laboratory for the aggregate components or aggregate blend.

Job mixes outside the above design range will be considered by the Engineer based on mix performance documented by the supplier to eliminate or minimize flushing or visual deficiencies and may include changes to gradation, asphalt content and/or the use of fibers. The Engineer may require limited production of less than 300 tons for verification of an acceptable mix, prior to the Engineer's approval of the job mix.

IV. SURFACE PREPARATION

Prior to the commencement of paving operations, the existing pavement surface shall be cleaned of all accumulated dust, mud, vegetation or other debris, which may affect the bond of the thin lift hot mix asphalt overlay by the Contractor.

Pavement cracks or joints ¼ inch or more in width shall be cleaned and filled with a sealant material conforming to the Special Provision For Sealing Cracks in Asphalt Concrete Pavements or Hydraulic Cement Concrete Pavement. Pavement markers, thermoplastic pavement marking and tape pavement markings shall be removed prior to the commencement of paving operations. Pavement irregularities greater than 1 inch in depth shall be filled with a material approved by the Engineer.

Utility structures shall be protected and referenced prior to paving for location and adjustment (when necessary) after paving at no cost to the Department.

V. TACK COAT

A tack coat of asphalt emulsion meeting the requirements specified herein or other emulsion approved by the Engineer shall be applied prior to placement of the asphalt concrete. The tack coat shall be placed within 3 seconds of placement of asphalt concrete except as otherwise stated hereinafter or directed by the Engineer. At no time should any part of the paving machine come into contact with the tack coat before the asphalt concrete wearing course is applied. The emulsion shall be uniformly applied with a paver spray bar conforming to the requirements of Section 314.04(b) of the Specifications, except when using hand spray equipment for tacking areas inaccessible to the paver spray bar as directed by the Engineer. When using hand spray equipment, placement of the tack coat shall be done prior to paving. The emulsion asphalt shall be applied at a temperature recommended by the supplier at a rate of 0.20 to 0.30 gallons per square yard unless otherwise approved by the Engineer. Emulsion asphalt shall conform to the following

Test on Emulsion	**Method**	**Min**	**Max**
Viscosity at 77 ^{o} F, SSF	ASTM D88	20	100
Sieve Test, %	ASTM D244	—	0.05
24 hour storage stability, % (Note 1)	ASTM D244	—	1
Residue from distillation at 400^{o} F, % (Note 2)	ASTM D244	63	
Oil portion from distillation ml of oil per 100g emulsion			2
Demulsibility, % 35 ml 0.02 N CaCl2 or 35 ml 0.8% dioctyl sodium sulfosuccinate	ASTM D244	60	

Test on Residue From Distillation		Min	Max
Solubility in TCE, % (Note 3)	ASTM D2042	97.5	

Elastic Recovery, % (Note 4)	ASTM D6084	58	—
Penetration @ 77 ^{o} F, 100 g, 5 sec. dmm.	ASTM D5	60	150

Note 1: After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

Note 2: ASTM D244 with modifications to include a 400 ^{o} F +/- 10 ^{o} F maximum temperature to be held for a period of 15 minutes.

Note 3: ASTM D 2042, Test Method for Solubility of Polymer-Modified Asphalt Materials in Trichloroethylene

Note 4: With exception that the elongation is 20 cm and the test temperature is 50 ^{o} F.

VI. PLACEMENT OF HOT MIX ASPHALT

The application rates of the overlay shall range from 80 lbs/sy to 85 lbs/sy in order to result in a ¾" compacted lift thickness.

The thin lift of hot mix asphalt shall be placed by a paver designed for the placement of thin lifts as designated in the contract. The hot mix asphalt shall be delivered to the paver hopper at a temperature of 315^{o}F +/- 15^{o}F measured in the paver hopper. The paver shall be capable of placing the hot mix asphalt at a speed of 30 feet per minute. When the base temperature is 50^{0}F or above, placement of the asphalt concrete wearing course shall be permitted.

VII. COMPACTION

Two steel double drum rollers weighing no less than 10 tons shall perform compaction of the hot mix asphalt. No less than two passes shall be completed before the surface temperature of the asphalt has reached 185^{o}F.

VIII. ACCEPTANCE

The Contractor shall perform a gradation, and asphalt cement content on one sample taken in a random manner approved by the Engineer from each 500 tons of production. The material will be considered acceptable for gradation and asphalt content, if the results obtained are within the tolerance allowed from the job mix formula in the above table. Material represented by test results outside the tolerance may be removed and replaced with acceptable material by the Contractor at no additional cost to the Department at the discretion of the Engineer.

Should visual examination by the Engineer reveal that the material in any load, or portion of the paved roadway is contaminated, segregated, or flushed with asphalt cement, that load, or portion of the paved roadway may be rejected without additional sampling of the material.

IX. WARRANTY

The Contractor shall provide a one-year warranty from the date of final acceptance on all thin hot mix asphalt concrete overlay surfaces. The Department will periodically monitor the overlay surface installed throughout the warranty period for compliance and acceptability. The Contractor shall repair any area that fails before the end of the warranty period and shall do so within 14 days after Department notification unless otherwise directed by the Department. Failure of the thin hot mix asphalt concrete overlay surface is defined as the loss of adhesion of the material to the underlying layer resulting in a pothole greater than 1 square foot of area (delamination). The Engineer shall notify the Contractor of the date for the warranty inspection at the end of the warranty period and the Contractor shall be present at the inspection.

X. MEASUREMENT AND PAYMENT

Thin hot mix asphalt concrete will be measured in tons and paid for at the contract unit price per ton, which shall include tack coat, surface preparation (except crack and joint sealing), all materials, additives, labor and equipment as described herein to install and complete the work. Crack and joint sealing will be paid in accordance with Special Provision for Sealing Cracks in Asphalt Concrete Pavements or Hydraulic Cement Concrete Pavement (Prior to Overlay).

Payment will be made under:

Pay Item	**Pay Unit**
Thin Hot Mix Asphalt Concrete	Ton

APPENDIX B – QUESTIONNAIRE

Thin Microsurfacing Treatment Questionnaire Form

Thin Micro-surfacing Treatment Questionnaire

1. Respondent information
   Contact Name/Title:
   Agency/Organization/State:
   Tel./Email:

2. Type of Agency/Organization:
   ☐ Federal ☐ State ☐ Municipal Agency ☐ County Agency ☐ Private Organization

3. Does your agency use surface treatments (less than 3/4" to 1" thickness) for pavement maintenance or pavement preservation?
   ☐ Yes ☐ No (Skip to end)

4. Please check/fill all of the following listed preservation activities used in your agency.

Types	Frequency Used? Regularly-**R** Irregularly-**I** Seldom-**S** Experimentally-**E** Never-**N**	Expected Life (years)	Cost ($/yd^2)	Pavement Conditions (Good, Fair, Poor)	Traffic Level A: ADT>10,000; B: 5,000<ADT<10,000; C: 2,000<ADT<5,000; D: ADT<2,000
Thin Overlay	☐				
Micro-surfacing	☐				
Crack Sealing	☐				
Fog Seal	☐				
Slurry Seal	☐				
Chip Seal	☐				
Cape Seal	☐				
Sand Seal	☐				
Novachip	☐				
Others					

5. Does your agency have Standard Policy and/or specifications for these treatments? ☐ Yes ☐ No
If yes, please provide reference, links or otherwise indicate how they can be obtained below.

6. How is the decision made to use a thin surface treatment? If there are specific criteria, please attach.

☐ Pavement Condition Rating or Index	☐ Age of Surface (Cyclic)
☐ Crack Survey	☐ Rutting
☐ Friction/Skid Number	☐ Roughness
☐ Amount of Oxidation	☐ No Trigger Point
Others, please specify	

7. Is there a maximum traffic volume on roads to which your agency applies thin surfacing treatments? If so, indicate below.
   ☐ <2,000 ☐ <5,000 ☐ <10,000 ☐ <20,000 ☐ >20,000

8a. How do you select asphalt material grades for thin surface treatment work?
   ☐ Standard policy ☐ Design methodology ☐ Contractor recommendation

8b. Please provides reference links or other information to related materials below.

9. How do you select asphalt binder type for thin surface treatments?
   ☐ Local Climate ☐ Pavement Geography ☐ Traffic Volume or ESALs ☐ Past Experience
   ☐ Compatibility with aggregate ☐ Other, please specify:

Appendix C.1 – MnDOT Specification

Bituminous Seal Coat

S-1 (2356) BITUMINOUS SEAL COAT

REVISED 12/29/09

SP2005-136

Mn/DOT 2356 is deleted and replaced by the following:

S-1.1 DESCRIPTION

Construct a seal coat on a prepared surface. A seal coat is the application of bituminous material, followed immediately by an application of a single layer of aggregates. Fog seal the completed seal coat.

S-1.2 MATERIALS

A. Bituminous Material

1. Provide CRS-2P, bituminous material for seal coat, and CSS-1h **diluted one (1) part emulsion to one (1) part water** for fog sealing, shall meet the following requirements for the type and grade specified. Only Bituminous Material supplied from a certified source is approved for use. A list of certified sources is on file at the Chemical Laboratory.

A. Emulsified Asphalt

The emulsified asphalt shall meet the requirements of **AASHTO M-316-99 CRS-2P** subject to the following modification.

1. The CRS-2P shall be distilled at 400^{o}F for 20 minutes.

2. **Polymer-Modified Cationic Emulsified Asphalt, (CRS-2P) shall be produced by using polymer modified base asphalt only. The use of Latex modification shall not be allowed. Any emulsion not meeting this requirement shall not be used.**

Provide a CSS-1h, bituminous material for fog seal, as specified in Mn/DOT 3151.E. **All diluted asphalt emulsion shall be diluted at place of manufacture. Field dilution will not be allowed.**

B. Seal Coat

Provide a Class A, B, or C aggregate, as specified in Mn/DOT 3137.2B. Use aggregates, uniform in quality and free from wood, bark, roots and other deleterious materials. All Class C aggregates shall be 80% crushed one face (mechanical or natural), of the plus 4.75 mm [**#4**] fraction (use Mn/DOT Laboratory Manual Method 1214). Gradation and quality requirements are specified in Table 1. All percentages are by weight. The aggregate size to be used will be shown in the Plans.

Table 1 (Values are the percent passing the sieve).

Sieve Size	**FA-1**	**FA-2**	**FA- 2 1/2**	**FA-3**	**FA-3 1/2**	**QC range**
12.5 mm [**1/2 inch**]	100	100	100	100	100	
9.5 mm [**3/8 inch**]	100	100	100	100	90-100	±5%
6.3 mm [**1/4 inch**]	100	100	0-80	0-70	0-70	±7%
4.75 mm **[# 4**]	0-100	0-100	0-50	0-25	0-25	±7%
2.36 mm [**# 8**]	---	0-40	0-12	0-5	0-5	±4%
1.18 mm [**# 16**]	0-30	0-10	0-5	---	---	±4%
300 µm [**# 50**]	0-15	0-5		---	---	±4%
150 µm [**# 100**]	0-5	---		---	---	±4%
75 µm [**# 200**]	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	
Material Tests						
% Shale, max. Mn/DOT 1209	5	5	5	3	2	
Flakiness Index, max. %, FHL T 508[1]	N/A	25	25	25	25	
Los Angeles Rattler, max. % loss, AASHTO T 96 (Mn/DOT modified)				35	35	

[1] Aggregate retained on each sieve, which comprises at least 4 percent of the total sample shall be tested.

C. Water

Use potable water, compatible with the seal coat

S-1.3 SEAL COAT DESIGN

The quantity on the Plans for bituminous material for seal coat is for estimating and bidding purposes only.

The Contractor shall design the seal coat using Mn/DOT's seal coat design method, available through the Mn/DOT web site. Base the design on the traffic volume(s) and pavement condition(s). Determine the starting application rate for the bituminous material and seal coat aggregate. Provide the following design information to the Project Engineer, two weeks before construction is to begin:

(1) Test results required in Table 1.
(2) Seal coat aggregate design application rate.
(3) Bituminous material design application rate.
(4) Loose unit mass [**weight**] of the aggregate.
(5) Bulk specific gravity of the aggregate.
(6) 150 pound sample of each proposed aggregate source.

All Mn/DOT projects will have the design reviewed by Mn/DOT District Materials Office personnel. Failure of the Contractor to submit 150 pounds of material for each source to Mn/DOT for design review at least 14 days before start of construction may result in postponement of the start of the Project until a design has been completed as determined by the Engineer. The Contractor will be charged one working day for each weekday that the Project is delayed.

After the seal coat design has been established, the aggregate supplied to the Project shall conform to the QC tolerances in Table 1. The tolerance range does not extend the specification limits set in Table 1.

Note: The seal coat aggregate design rate is the minimum amount of material based on the design program. If additional material is needed, this material is incidental to the square meter [**square yard**] bid price.

Schedule of Price Reduction for Seal Coat Construction.

Failing gradations will result in a price reduction. The Contract bid price for seal coat will be reduced 1 percent, for each 1 percent passing outside of the requirements for any sieve, except the 75 µm [**# 200**]

sieve. The 75 µm [**# 200**] sieve will have **2** percent price reduction for each 0.1 percent outside of the specification. All failing results will be added together. These deductions apply to the specification range in Table 1. **The Contract bid price for seal coating will be determined by combining the bid price for Traffic Control, Mobilization, Bituminous Materials for seal coating and Seal Coating by square yard.** If any gradations fall outside of the quality control range but within specifications, stop construction and a new design will be required.

Failing flakiness tests will result in a $1,000 reduction for each failing test.

S-1.4 EQUIPMENT

A. Distributor

Use a distributor as specified in Mn/DOT 2321.3C1.

B. Aggregate Spreader

Use a self-propelled mechanical type aggregate spreader capable of distributing the aggregate uniformly to the required width and at the designed rate. Use a self-propelled type mounted on pneumatic-tired wheels.

C. Pneumatic-Tired Rollers

Provide a minimum of three (3) self- propelled pneumatic-tired rollers as specified in Mn/DOT 2321.3C2.

D. Brooms

Provide motorized brooms with a positive means of controlling vertical pressure and capable of cleaning the road surface prior to spraying bituminous material and removing loose aggregate after seal coating.

S-1.5 CONSTRUCTION REQUIREMENTS

A. Weather Limitations

Construct seal coat operations (including traffic restrictions on the freshly constructed seal coat) and fog sealing according to the following:

(1) Not before May 15 or after August 10, for the part of Minnesota located in the North and North-Central Road Spring Restriction Zone. Not before May 15 or after August 31, for the part of Minnesota located south of the North and North-Central Spring Road Restriction Zone.
(2) Work only during daylight hours.
(3) Start when the pavement and air temperature are 15.5 ºC [**60 °F**] and rising.
(4) The road surface may be damp. There shall be no standing water.
(5) No construction is allowed in foggy weather.

B. Road Surface Preparation

Clean all pavements to be seal coated. Sweep the pavement with a motorized broom to remove loose material. Clean depressions not reached by the power broom, using hand brooming.

Cover iron (manholes, gate valve covers, catch basins, sensors, etc.) to prevent adherence of the bituminous material. Remove the protective coverings before opening the road to traffic.

C. Application of Bituminous Material

Begin the rate of application for the bituminous material as determined by the seal coat design. Construct a test strip 30 meters [**100 feet**] long to ensure the bituminous material application rate is adequate. After applying the bituminous material to this test strip, place the seal coat aggregate at the design application rate. Inspect the aggregate in the wheel paths for proper embedment. Make adjustments to the rate of application, if necessary. Construct one full lane width at a time. Make additional adjustments to the rate of application during the Project, if needed.

Apply the bituminous material above the minimum limits specified below:

Bituminous Material	Minimum Temperature	Ideal Temperature
CRS-2P	60° C [**140° F**]*	76.6-82.2º C [**170-180º F**]
CSS-1h	37.7° C [**100° F**]	

* Intended for uniform lay down of emulsion.

D. Application of Seal Coat

Prior to construction, calibrate the aggregate spreader in accordance with ASTM D5624, in the presence of the Engineer. The allowable deviation in the amount of aggregate spread by maximum not ±0.5 kg/m^2 [**± 1 pound per square yard**.

Provide uniformly moistened aggregates, which are damp at the time of placement. Place aggregate within one minute after the bituminous material has been sprayed. The edges of the aggregate applications shall be sharply defined. Previously used (sweeping) aggregates will not be allowed.

E. Rolling Operations

Complete the initial rolling within 2 minutes after applying the aggregate. Proceed at a recommended speed less than or equal to 8 km per hour [**5 miles per hour**], to prevent turning over aggregate. Make a minimum of three complete passes over the aggregate. Roll the aggregate so the entire width of the treatment area is covered in one pass of all the rollers.

F. Sweeping

Sweep off the surplus aggregate on the same day of the seal coat construction. Re-sweep areas the day after the initial sweeping. Dispose of the surplus seal coat aggregate in a manner satisfactory to the Engineer.

G. Protection of the Surface

No traffic is permitted on the seal coated road surface until after the specified rolling has been completed and the bituminous material has set and will not pick up on vehicle tires.

H. Protection of Motor Vehicles

The Contractor is responsible for claims of damage to vehicles until the roadways and shoulders have been swept free of lose aggregate and permanent pavement markings have been applied. If permanent pavement markings are to be applied by State forces, the Contractor's responsibility end's after completion of the fog seal and placement of temporary pavement markings.

I. Application of Bituminous Material for Fog Sealing

Fog seal completed seal coated areas, after sweeping and before placement of permanent pavement markings. Construct the fog seal as specified in Mn/DOT 2355, as modified as follows: Construct a 30 meter [**100 foot**] test strip. Review the application of diluted (1:1) bituminous material and adjust the application rate as needed. Apply between 0.3 to 0.8 liters per square meter diluted [**0.07 to 0.18 gallons per square yard, diluted**]. Apply the fog seal to minimize the amount of overspray. Do not allow traffic on the fog seal until it has cured.

J. Progress of Work

Allow the seal coat to cure a minimum of one day before fogging. . Interim pavement markings can be placed after the fog seal cures. The permanent pavement markings **using Latex paint** shall not be placed **before** three days after placing the fog seal. **All other types of permanent pavement marks require a 14 day curing time after placement of fog seal.**

S-1.6 METHOD OF MEASUREMENT

A. Bituminous Material

1. Measure the bituminous material for fog seal by volume, at 15 °C [**60 °F**], **undiluted.** This material must be diluted (1:1) before application at place of manufacture.
2. Measure the bituminous material for seal coat by volume, at 15 °C [**60 °F**].

B. Seal Coat

Measure the seal coat by area of pavement surfaced.

S-1.7 BASIS OF PAYMENT

(A) Payment for bituminous material for fog seal: as specified in Mn/DOT 2355.5.

(B) Payment for the accepted quantity of bituminous material for seal coat (including any required additives) at the Contract bid price of measure is compensation in full for all costs of furnishing and applying the material as specified.

(C) Payment for the accepted quantity of seal coat at the Contract bid unit price of measure is compensation in full for all costs of furnishing and applying the material as specified.

(D) Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure. Such payment, in each instance, is compensation in full for all costs incidental thereto.

Item No.	Item	Unit
2355.502	Bituminous Material for Fog Seal	Liter [**Gallon**]
2356.505	Bituminous Material for Seal Coat	Liter [**Gallon**]
2356.604	Bituminous Seal Coat	Square meter [**Square yard**]

Appendix C.2 – MnDOT Specification

Microsurfacing

S-1 (2356) SEAL COAT - MICRO-SURFACING

Always use SP2005-138.1 (BITUMINOUS TACK COAT) with this writeup.

REVISED 04/08/10

SP2005-138

Mn/DOT 2356 is hereby deleted and replaced with the following.

S-1.1 DESCRIPTION

This work is the construction of micro-surfacing on a prepared pavement. Micro-surfacing is a mixture of: polymer modified asphalt emulsion, well-graded crushed mineral aggregate, mineral filler, water and other additives.

S-1.2 MATERIALS

A. Asphalt Emulsion

Provide a polymer modified CSS-1h bituminous material as specified in Mn/DOT 3151, and the following:

Quality (on emulsion)	Test	Requirement:
Residue after Distillation [1]	AASHTO T59	62%, min

Quality (on residue)	Test	Requirement:
Softening Point	AASHTO T53	57 °C [**135 °F**], min
Penetration at 25 °C [**77 °F**]	AASHTO T49	40 – 90
Absolute Viscosity at 60 °C [**140 °F**]	ASTM D 2171	800 Pa·s, min

Use only natural latex polymers **or manmade latex polymers proven equal**. Suppliers of new synthetic latex polymer must do the following to be proven equal to natural latex. They must build on a Minnesota State highway one (1) mile of micro surfacing meeting all the requirements for micro surfacing as outlined in this special provision. This test section will be review by the supplier and State for one year to determine if the manmade latex performs satisfactorily.

Use a minimum of 3% polymer solids.

1. The temperature for the distillation procedure shall be held at 177±5 °C [**350 °F±9 °F]** for 20 minutes. Complete the entire distillation procedure within 60 minutes from the first application of heat. The cement mixing test shall be waived.

B. Aggregate

Provide a Class A, or Taconite Tailings, as specified in Mn/DOT 3139. **The use of Class B aggregate to be blended with Class A or Taconite Tailings will be allowed only if the following methods are followed.** When blending aggregate types, material passing the 9.5 mm [**3/8 inch**] sieve and retained on 1.18 mm [**#16**] shall not be less than 90 percent Class A and/or Taconite Tailings, by weight. Also, meet the following requirements:

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Tests on Aggregate:		Requirement:
Sand Equivalent	AASHTO T176	60 percent, min
Abrasion Resistance[1]	AASHTO T96	30 percent, max
Soundness (using $MgSO_4$)[2]	AASHTO T104	25 percent, max

1. Use grading C for Type 3 material. Use grading D for Type 2 material.
2. The Soundness test shall be done on the Class B aggregate component of the blend, if applicable.

TABLE 1 Percent Passing (AASHTO T11, AASHTO T27).

Sieve Size	Mn/DOT Type 1	Mn/DOT Type 2 ISSA* Type II	Mn/DOT Type 3 ISSA* Type III	QC TOLERANCES Percent in JMF for each sieve size
9.5 mm **[3/8 inch]**	100	100	100	
4.75 mm **[# 4]**	100	90 – 100	70 – 90	±5.0
2.38 mm **[# 8]**	85-100	65 – 90	45 – 70	±5.0
1.18 mm **[# 16]**	72-92	45 –70	28 – 50	±5.0
600 µm **[# 30]**	50-75	30 – 50	19 – 34	±5.0
300 µm **[#50]**	35-55	18 – 30	12 – 25	±4.0
150 µm **[#100]**	15-35	10 – 21	7 – 18	±3.0
75 µm **[#200]**	5-15	5 – 15	5 – 15	±2.0

* International Slurry Surfacing Association

C. Mineral Filler

Provide Portland cement or hydrated lime, based on the mix design results.

1. Portland cement, type I as specified in Mn/DOT 3101.

2. Hydrated lime as specified in Mn/DOT 3106.

D. Water

Provide potable water as specified in Mn/DOT 3906.

S-1.3 MIXTURE REQUIREMENTS

A. Mix Design

Submit a complete mix design, prepared by a qualified laboratory experienced in micro-surfacing technology, ten working days prior to the start of production. List the source of all materials used for the mix design. Show that the individual proportions of each of the materials when combined shall meet the following mix design requirements:

Test	Description	Specification
ISSA TB-114	Wet Stripping	90 percent, min
ISSA TB-100	Wet Track Abrasion Loss - One Hour Soak - Six Day Soak	 538 g/m^2 max [**1.8 oz/ft^2**] 807 g/m^2 max [**2.6 oz/ft^2**]
ISSA TB-144	Saturated Abrasion Compatibility	3 g loss, max
ISSA TB-113	Mix Time at 25 °C [**77°F**]	Controllable to 120 sec., min
	Mix Time at 37.4 °C [**100°F**]	Controllable to 35 sec., min

The Job Mix Formula (JMF) shall be within the following limits:

Residual Asphalt: 5.5 – 10.5 percent, by dry weight of aggregate.
Mineral Filler: 0.25 - 3.0 percent, by dry weight, of aggregate.

A change in aggregate, aggregate blend, or asphalt emulsion source will require a new mix design.

B. Mix Design Format

Submit the final mix design in the following format.

a. Source of each individual material.
b. Aggregate:
   1. Gradation
   2. Sand Equivalent

3. Abrasion Resistance
4. Soundness

c. Field Simulation Tests:
1. Wet Stripping Test
2. Wet Track Abrasion Loss
3. Saturated Abrasion Compatibility
4. Trial Mix Time @ 25°C [**77 °F**] and 37.4°C [**100 °F**].

d. Interpretation of Results and the Determination of a Job Mix Formula (JMF):
1. Percentage of Mineral Filler (minimum and maximum)
2. Percentage of Water, including aggregate moisture (minimum and maximum)
3. Percentage of Mix Set Additive (if required)
4. Percentage of Modified Emulsion
5. Residual Asphalt Content of Modified Emulsion
6. Percentage of Residual Asphalt

e. Signature and Date

S-1.4 CONSTRUCTION REQUIREMENTS

A. Equipment

A1. Mixing Machine

Provide a continuous micro-surfacing lay down machine. Provide a positive connection conveyer belt aggregate delivery system and an inter-connected positive displacement, water-jacketed gear pump to accurately proportion aggregate and asphalt emulsion. Locate the mineral filler feed so the proper amount of mineral filler is dropped on the aggregate before discharging into the pugmill. The pugmill must be a continuous flow twin shaft multi-blade type and a minimum of 1.2 m [**4 feet**] long. The blade size and side clearance must meet the equipment manufacturer's recommendations. Introduce the asphalt emulsion within the first one-third of the mixer length to ensure proper mixing of all materials prior to exit from the pugmill.

Use a self propelled, front feed and continuous loading machine with duel driving stations. Provide a remote forward speed control at the back mixing platform so that the back operator can control forward speed and the level of mixture in the spreader box. Use sufficient transport units to assure a continuous operation during mix production and application.

Provided individual volume or weight controls for proportioning each material. Position the controls to be accessible at any time. Use the controls to calibrate the operation prior to production and to determine the amount of each material used at any time.

Provide a water pressure system and nozzle type spray bar to spray water ahead of and outside the spreader box when required. Apply water at a rate to dampen the surface, but not to create free flowing water, ahead of the spreader box.

A2. Spreader Box

Spread the mix uniformly, using a mechanical type spreader box, attached to the mixer and equipped with **spiral augers** mounted on adjustable shafts. Continually agitate and distribute the mixture. Provide sufficient agitation to prevent stagnation, excessive build-up, or lumps. Equip the spreader box with front and rear flexible seals to achieve direct contact with the road. Use a secondary strike off attached to the spreader box to provide a smooth finished surface texture. The use of burlap drags is not allowed.

A3. Rut Filling Box

Provide a steel V-configuration screed rut box commercially designed and manufactured to fill ruts. The rut box shall achieve a mixture spread width of 1.5 m to 1.8 m [**5 to 6 feet**] and have a strike off to control crown.

A4. Weighting Equipment

Use of portable scales to weight material must be certified as specified in Mn/DOT 1901.8, and as modified as follows. Re-certify the scale after any change in location. Randomly spot check the scale at a rate of once per week or one per Project, which ever is greater.

A5. Miscellaneous Equipment

Provide hand squeegees, shovels and other equipment necessary to perform the work. Cleaning equipment such as power brooms, air compressors, water flushing equipment, and hand brooms shall be adequate for surface preparation.

B. Operations

B1. Micro-surfacing Types

1. Rut Fill.....Use Mn/DOT Type 3
Rut fill pavement segments greater than 305 m [**1000 feet**] in length, when the average rut depth exceeds 12.7 mm [**1/2 inch**]. Provide a rut box for each designated wheel track. A clean overlap and straight edges shall be required between wheel tracks. Construct each rutted wheel track with a crown to allow for proper consolidation by traffic.

2. Scratch Course ..... Use Mn/DOT Type (2 or 3, selected by designer)
Apply full lane width in one course. Use a metal strike off bar on the spreader box. There shall be no excess buildup or uncovered areas.

3. Surface Course.....Use Mn/DOT Type 2
Apply full lane width in one course. There shall be no excess buildup or uncovered areas.

B2. Pre-Paving Meeting

A pre-paving meeting between the Contractor and Engineer will be held on-site prior to beginning work. The agenda for this meeting will include: Job Mix Formula, condition of all equipment, calibration of equipment, test strip(s), detailed work schedule, and traffic control plan.

B3. Calibration

Calibrate each mixing machine prior to use. Maintain documentation showing individual calibrations of each material at various settings, which relate to the machine's metering devices. Supply all materials and equipment, including scales and containers necessary for calibration. A change in aggregate or asphalt emulsion source will require recalibration of all machines on the job.

B4. Test Strip

Construct a 305 mm [**1000 foot**] long, one lane wide test strip, for each machine used on the Project. Begin construction after dark, no sooner than one hour after sunset and no later than one hour before sunrise. Compare the machines for variances in surface texture and appearance.

The emulsion shall not exceed 50 °C [**122 ºF**]. Postpone the construction of the test strip until the emulsion temperature is under 50 °C [**122 ºF**].

Construct a new test strip when the system used in job mix changes or there is field evidence that the system is out of control. The system includes the following: emulsion, aggregate supplier, type of mineral filler, and the lay down machine.

In place of construction of a test strip, a Contractor may submit evidence of a successful construction of a test strip on another State project using the same mix designs. The project must have been constructed in the same construction season. The system used for the test strip must be identical to all parts of the proposed system.

Carry normal traffic on the test strip within one hour after application, without any damage occurring. The Engineer will inspect the completed test strip after 12 hours of traffic to determine if the mix design is acceptable. Full production may begin after the Engineer accepts a test strip. The Engineer will approve the location of the test strip.

B5. Surface Preparation

Prepare and maintain a clean surface immediately prior to placement of the micro-surfacing. Clean the surface of all loose material, vegetation, plastic markings, and other objectionable material.

B6. Fog Seal

Apply Fog Seal to all surfaces prior to the first course of micro surfacing. Provide a CSS-1 or CSS-1h emulsion as specified in Mn/DOT 3151. Apply the material as specified in Mn/DOT 2357, and the following. Use one part emulsion to one part water **diluted at place of manufacture**. Apply the diluted emulsion at 0.23 – 0.45 liter/m^2 [**0.05-0.10 gallons per square yard**]. **Fog Seal will be paid for by the liter [gallon] this pay will cover cost of asphalt emulsion and all placement costs**.

Restrictions

Fog seal operation shall be conducted in a manner that offers the least inconvenience to traveling public.

The fog seal shall not be applied when the road surface or weather conditions are unsuitable as determined by the Engineer. Limit the daily application of fog seal to the area if pavement that will be micro surfacing that day. No fog sealed areas will be allowed to be opened to traffic until after the first course of micro surfacing has been applied and cure. The fog seal must be cured before micro surfacing can be applied.

Protect drainage structures, monument boxes, water shut-offs, etc., during application of the fog seal and the micro surfacing.

B7. Surface Quality

The restored transverse pavement cross section as measured using a 3 m [**10 foot**] straight edge shall not exceed 9.5 mm [**3/8 inch**], or 4.8 mm [**3/16 inch**] when measured with a 1.8 m [**6 foot**] straight edge. The preceding shall not apply to any area within 300 mm [**12 inches**] of the edge line, lane line or center line.

Construct the surface course without excessive scratch marks, tears, rippling, or other surface irregularities. Repair tear marks greater than 12.7 mm [**1/2 inch**] wide and 100 mm [**4 inches**] long, and marks greater than 25 mm [**1 inch**] wide and 25 mm [**1 inch**] long. Repair transverse ripples or streaks greater than 6.35 mm [**1/4 inch**] in depth as measured by a 3 m [**10 foot**] straight edge.

Constructed longitudinal joints, with no more than 6.35 mm [**1/4 inch**] overlap thickness as measured with a 3 m [**10 foot**] straight edge, and less than a 76 mm [**3 inch**] overlap on adjacent passes. Longitudinal construction joints and lane edges shall coincide with the proposed painted lane lines. Place overlapping passes, on the uphill side, to prevent ponding of water.

Construct transverse joints, with no more than 3 mm [**1/8 inch**] difference in elevation across the joint as measured with a 3 m [**10 foot**] straight edge.

Construct edge lines along curbs and shoulders, with no more than 50 mm [**2 inches**] of horizontal variance in any 30.5 m [**100 foot**] location. No runoff in these areas will be permitted.

If the micro-surfacing surface course cannot meet these requirements, stop the job until the problem is corrected.

Protect drainage structures, monument boxes, water shut-offs, etc.

All repairs to the above defects shall be made full width of paving pass with spreader box. Hand repairs after micro surfacing mix has set will not be allowed.

B8. Open to Traffic

The micro-surface must cure sufficiently to prevent pickup by vehicle tires, before it is open to traffic. Properly constructed micro-surface carries normal traffic within one hour after application, without any damage occurring. Protect the new surface from potential damage at intersections and driveways. Repair any damage to the surface, by traffic, at the Contractor's expense.

Confirm that the one hour cure is achieved on the first day of production, after construction of the test strip. The Engineer will conduct three (3) one hour spot checks. If any spot check fails, construction shall be stopped, and $5,000 will be deducted from the Contract amount for each failure. Construct a new test strip. If the test strip fails, $5,000 will be deducted from the Contract amount. After successful completion of three, one hour spot checks on the first day of production, the rate of one hour spot checks will be reduced to one per day, picked by the Engineer at his discretion. Any failure of a one hour spot check will result in a $5,000 deduction and construction of a new test strip. After a test strip, the one hour spot check rate will revert to the first day of production procedure.

B9. Weather Limitations

Begin construction when the air and pavement surface temperatures are both 10°C [**50°F**], or above and rising. Placement is not permitted if it is raining. Do not work if the temperature is forecasted to be below 0°C [**32°F**] within 48 hours. Do not start work after September 15.

S-1.5 QUALITY CONTROL

The Contractor is responsible for quality control (QC) sampling and testing.

A. Emulsion

Provide material certification and quality control test results for each batch of emulsion used on the Project. Include the supplier name, plant location, emulsion grade, and batch number on all reports. The emulsion must meet all requirements in this specification.

B. Aggregate

Determine the gradation, sand equivalence, and moisture content. Sample from the micro-surfacing machine. Sample at a rate of one per 453.6 metric tons [**500 tons**], or a minimum of one per day of mixture production.

B1. Gradation and JMF Tolerance

Run gradation tests according to AASHTO T11 and AASHTO T27 at the stockpile site. Report results to the Engineer, the same day as sample is taken. Provide companion samples if requested by the Engineer. The quality control tolerances for the JMF are listed in TABLE 1. The tolerance range does not extend the specification limits set in Table 1.

Schedule of Price Reduction for Micro-surfacing Construction.

Payment for micro-surfacing aggregate by the metric ton [**ton**] for failing gradation are based on a 2 percent price reduction for each 1 percent passing outside of either a QC tolerance requirements or a gradation range, for all sieves. This Schedule of Price Reduction for Micro Surfacing Construction only applies to non warranty work.

B2. Sand Equivalent Test

Determine the Sand Equivalent (AASHTO T176) for each aggregate gradation test. Quality control tolerance is ±7 percent, of the value established in the mix design (60% minimum). Run the sand equivalent test at the stockpile site. Report results to the Engineer, the same day as sample is taken.

B3. Moisture Content

Determine the moisture content. A visible change in moisture requires additional testing. Average daily moisture will be used to calculate the oven dry weight of the aggregate.

C. Asphalt Content

Calculate and record the percent asphalt content of the mixture from the equipment counter readings, randomly, a minimum of three times a day. The quality control tolerance is ±0.5 percent for a single test and the average daily asphalt content is ±0.2 percent from the JMF.

D. Application Rate

The design application rate shall be the total amount of micro-surfacing material placed to meet the requirements for cross section, and surfacing. This amount will be the combination of all courses placed.

E. Documentation

Provide a daily report to the Engineer within one working day with the following information:

- Date, Air Temperature at start up.
- Beginning and Ending locations for the days work.
- Length, Width, Total Area (m^2 [**square yard**]) covered for the day.
- Application Rate (kg/m^2 [**pounds per square yard**]), kilograms [**pounds**] of aggregate.
- Daily asphalt spot check reports, liters [**gallons**] of emulsion, unit mass [**weight**] of emulsion (kg/liter [**pounds per gallon**]).
- Asphalt Emulsion Bill of Lading.
- Counter Readings (and Beginning, and Ending, and Total).
- Control Settings, Calibration Values, Percent Residue in Emulsion.
- Percent of Each Material, Percent of Asphalt Cement.
- Calibration Forms
- Aggregate Certification or Shipment of Tested Stock Report
- Contractor's Authorized Signature

The Contractor shall sample and test the material in the stockpile to assure the correct passing material is provided prior to starting micro-surfacing production. The Contractor shall perform all tests according to referenced standards and maintain all quality control documentation and make them available to the Engineer upon request or at completion of work.

S-1.6 QUALITY ASSURANCE

Mn/DOT is responsible for quality assurance (QA) sampling and testing.

A. Asphalt Emulsion

Sample the first shipment. Also, provide one sample for every 200 m^3 (**50,000 gallons**) (approximately 181.4 metric tons [**200 tons**]).

B. Aggregate

Determine the gradation. Sample at a rate of one per 1360 metric tons [**1500 tons**] of aggregate used, or a minimum of one sample per Project, which ever is greater.

Determine the moisture content. Sample at a minimum rate of once per day.

S-1.7 METHOD OF MEASUREMENT

A. Bituminous Material

Measure the Bituminous Material for Micro-surfacing by volume, at 15 °C [**60** °F].

Measure Bituminous Material for Fog Sealing by volume, at 15° C [60°F] undiluted.

B. Micro-surfacing Rut Fill
Measure the Micro-surfacing Rut Fill by mass [**weight**], of **oven dry weight of aggregate.**

C. Micro-surfacing Scratch Course
Measure the Micro-surfacing Scratch Course by mass [**weight**], of **oven dry weight of aggregate.**

D. Micro-surfacing Surface Course
Measure the Micro-surfacing Surface Course by mass [**weight**], of **oven dry weight of aggregate.**

S-1.8 BASIS OF PAYMENT

A. Payment for the accepted quantity of Bituminous Material for Micro-surfacing (including any required additives) at the Contract bid price of measure shall be compensation in full for all cost of constructing the micro-surfacing as specified

B. **Payment for the accepted quantity of Bituminous Material for Fog Sealing at the Contract bid price of measured shall be compensation in full for all cost of constructing the Fog Sealing as specified.**

C. Payment for the accepted quantity of Micro-surfacing Rut Fill at the Contract bid price of measure shall be compensation in full for all cost of constructing the micro-surfacing rut fill as specified.

D. Payment for the accepted quantity of Micro-surfacing Scratch Course at the Contract bid price of measure shall be compensation in full for all cost of constructing the micro-surfacing scratch course as specified.

E. Payment for the accepted quantity of Micro-surfacing Surface Course at the Contract bid price of measure shall be compensation in full for all cost of constructing the micro-surfacing surface course as specified.

Item No.	Item	Unit
2356.606	Bituminous Material for Micro-Surfacing	Liter [**Gallon**]
2355.502	**Bituminous Material for Fog Sealing...**	**Liter [Gallon]**
2356.609	Micro-surfacing Rut Fill	metric ton [**Ton**]
2356.609	Micro-surfacing Scratch Course	metric ton [**Ton**]
2356.609	Micro-surfacing Surface Course	metric ton [**Ton**]

Appendix D – TxDOT Specification

Hot Asphalt-Rubber Surface Treatments

TXDOT: ITEM 318
HOT ASPHALT-RUBBER SURFACE TREATMENTS

318.1. Description. Construct a surface treatment consisting of 1 or more applications of a single layer of hot asphalt-rubber (A-R) binder covered with a single layer of aggregate.

318.2. Materials.

A. Asphalt-Rubber Binder. Furnish Type II or Type III A-R binder in accordance with Section 300.2.I, "Asphalt-Rubber Binders," as shown on the plans. Furnish a blend design for approval. Include in the design, at a minimum, the following:

- manufacturer and grade of asphalt cement;
- manufacturer and grade of crumb rubber;
- manufacturer, type, and percentage of extender oil, if used;
- test report on crumb rubber gradation in accordance with
- Tex-200-F, Part I;
- design percentage of crumb rubber versus asphalt content;
- blending temperature; and
- test results on the properties at reaction times of 60, 90, 240, 360,and 1,440 min. in accordance with Section 300.2.I, "Asphalt- Rubber Binders."

Furnish a new blend design if the grade or source for any of the components changes.

B. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a performance grade (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. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in Item 300.

C. Aggregate. Furnish aggregate meeting Item 302, "Aggregates for Surface Treatments," of the type and grade shown on plans. For final surfaces, unless otherwise shown on the plans, furnish aggregate with a minimum "B" surface aggregate classification.

318.3. Equipment.

A. Distributor. Furnish a distributor calibrated in accordance with Section 316.3, "Equipment," capable of keeping the rubber in uniform suspension and adequately mixing the asphalt, rubber, and any additional additives. If equipped with an onboard scale system or micro- motion meters for proportioning or payment, they must weigh or measure the load within a 0.4% accuracy in accordance with Item 520, "Weighing and Measuring Equipment."

B. Aggregate Spreader. Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the specified rate or as directed.

C. Rollers. Unless otherwise shown on the plans, furnish medium pneumatic rollers in accordance with Item 210, "Rolling."

D. Broom. Furnish rotary self-propelled power brooms.

E. Asphalt Storage and Handling Equipment. Furnish a recording thermometer in each tank to indicate the asphaltic temperature continuously.

Keep equipment clean and leak- free.

F. Hot Asphalt-Rubber Blending and Storage Equipment. Provide a mechanical blender for proper proportioning and thorough mixing of the asphalt and rubber. Use proportioning, weighing, and measuring devices meeting the requirements of Item 520, "Weighing and Measuring Equipment." If used, equip the asphalt-rubber binder storage tank with:

- a heating system to maintain the proper temperature of the binder,
- recording thermometer in each tank to indicate the asphalt-rubber binder temperature continuously,
- an internal mixing unit capable of maintaining a homogeneous mixture of asphalt and rubber, and
- a sampling port.

Keep hot asphalt-rubber binder free of contamination.

G. Aggregate Haul Trucks. Unless otherwise authorized, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.

H. Digital Measuring Instrument. Furnish a vehicle with a calibrated digital-measuring instrument, accurate to ±6 ft. per mile.

I. Truck Scales. Provide standard platform scales in accordance with Item 520, "Weighing and Measuring Equipment." Truck scales will not be required if the distributor has an adequate calibrated scale system.

J. Aggregate Heating System. If required, furnish a heating system that will:

- heat aggregate to the specified temperature,
- not damage aggregate,
- not leave fuel residue on heated aggregate, and
- provide a continuous recording thermometer to indicate aggregate temperature as it leaves the system.

318.4. Construction.

A. General. Asphalt application season will be as shown on the plans. Asphalt and aggregate rates are for estimating purposes only. The Engineer will adjust the rates for the existing conditions.

B. Temporary Aggregate Stockpile. The Engineer will approve the location of temporary aggregate stockpiles on the right-of-way before delivery. Place stockpiles in a manner that will not:

- obstruct traffic or sight distance,
- interfere with the access from abutting property, or
- interfere with roadway drainage.

Locate stockpiles a minimum of 30 ft. from the roadway when possible. Sign and barricade as shown on the plans.

C. Department-Furnished Aggregate. When shown on the plans, the Department will furnish aggregate to the Contractor without cost. Stockpile locations are shown on the plans.

D. Adverse Weather Conditions . Do not place hot asphalt-rubber surface treatment when, in the Engineer's opinion, general weather conditions are unsuitable. Apply surface treatment when the air temperature is 70°F and rising. Do not apply surface treatment when the air temperature is 80°F and falling. In all cases, do not apply surface treatment when surface temperature is below 70°F.

E. Mixing Hot Asphalt-Rubber. Mix in accordance with the approved blend design required in Section 318.2.A, "Asphalt-Rubber Binder."

At the end of each shift, provide the Engineer with production documentation, which includes the following:

- amount and temperature of asphalt cement before addition of rubber,

- amount of rubber and any extender added,
- viscosity of each hot asphalt-rubber batch just before roadway placement, and
- time of the rubber additions and viscosity tests.

F. Surface Preparation. Remove existing raised pavement markers in accordance with the plans. Remove dirt, dust, or other harmful material. When directed by the Engineer, apply a tack coat before applying the hot asphalt-rubber treatment on an existing wearing surface in accordance with Section 340.4.G.2, "Tack Coat."

G. Rock Land and Shot.

1. Definitions.

- A "rock land" is the area covered at the aggregate rate, as directed, with 1 truckload of aggregate.
- A "shot" is the area covered by 1 distributor load of asphaltic material.

2. Setting Lengths. Calculate the lengths of each. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphaltic material to complete entire shot length. Mark shot length before applying hot asphalt-rubber. When directed, mark length of each rock land to verify the aggregate rate.

H. Hot Asphalt-Rubber Placement.

1. General. Adjust the application temperature, not exceeding 425°F, to obtain the proper application characteristics. Uniformly apply at the rate specified or as directed.

The maximum shot width is 13 ft. Adjust the shot width so operations do not encroach on traffic or interfere with the traffic control plan, as directed. Use paper or approved material at the beginning and end of each shot to construct a straight transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, longitudinal joints must match lane lines.

2. Limitations. Do not apply asphalt to the roadway until:

- traffic control methods and devices are in place as shown on the plans or as directed,
- the loaded aggregate spreader is in position and ready to begin,
- haul trucks are loaded with enough aggregate to cover the shot area, and
- haul trucks are in place behind the spreader box.

3. Test Sections. Place a test section to demonstrate that equipment is capable of uniformly mixing and placing the hot asphalt-rubber. The Engineer may stop work at any time and require additional test sections to be shot if:

- the application is not uniform;
- on 3 consecutive shots, application rate differs by more than 0.03 gal. per square yard from the rate directed; or
- any shot differs by more than 0.05 gal. per square yard from the rate directed.

The Engineer will approve the test section location.

4. Nonuniform Application. Stop application if not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine cause of nonuniform application and correct it.

I. Aggregate Placement. The aggregate must be surface dry before application. When shown on the plans, preheat aggregate between 250°F and 350°F. Cover each load with standard tarping material to minimize the temperature drop of the preheated aggregate. Immediately after the distributor has started spraying the hot asphalt-rubber, uniformly apply the aggregate at the rate specified by the Engineer.

J. Rolling. Start rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover entire mat width in 1 pass (1 direction). Roll in a staggered pattern. Unless otherwise shown on the plans, make a minimum of 5 passes.

If rollers are unable to keep up with spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires free of asphalt.

K. Repair. Repair areas where coverage is incomplete. Make repairs by patching, hand spotting, or other method, as approved. When necessary, apply additional hot asphalt-rubber material to embed the aggregate.

L. Brooming. After rolling, sweep away excess as soon as aggregate has sufficiently bonded.

M. Final acceptance. Maintain surface treatment until the Engineer accepts the work. Repair any surface failures. Before final project acceptance, remove all temporary stockpiles and restore the area to the original contour and grade.

318.5. Measurement.

A. Hot Asphalt-Rubber. Hot asphalt-rubber mixture, including all components, will be measured in tons just before delivery to the point of application using certified scales, an onboard scale system, or micro-motion meters meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved.

B. Aggregate. Aggregate will be measured by the cubic yard in the trucks as applied to the road.

C. Loading, Hauling, and Distributing Aggregate. When the Department furnishes the aggregate, the loading, hauling, and distributing will be measured by the cubic yard in the trucks as applied on the road.

318.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Hot Asphalt-Rubber," of the type specified; "Aggregate," of the type, grade and surface aggregate classification specified; or "Loading, Hauling, and Distributing Aggregate". These prices are full compensation for surface preparation, tack coat, heating and mixing, hauling and placing all materials, rolling and removing excess aggregate, cleaning up stockpiles, test sections, equipment, labor, tools, and incidentals.

Appendix E – NYSDOT Specification

6.3 mm Polymer-Modified Thin Overlay

ITEM 402.06810118 6.3-mm F1 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION
ITEM 402.06811118 PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06810118
ITEM 402.06820118 6.3-mm F2 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION
ITEM 402.06821118 PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06820118
ITEM 402.06830118 6.3-mm F3 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION
ITEM 402.06831118 PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06830118

DESCRIPTION

This work shall consist of developing a Polymer-Modified HMA mixture and constructing it in accordance with the contract documents and as directed by the Engineer. This mixture requires the use of Item 407.02010018, *Tack Coat for 6.3-mm Polymer-Modified* HMA, as the tack coat.

MATERIALS

The materials and composition for Polymer-Modified mixtures shall meet the requirements specified in §401-2 Materials, except as noted herein.

Produce Polymer-Modified HMA in accordance with the procedures outlined in this specification and Material Method 5.16, Superpave Hot Mix Asphalt Mixture Design and Mixture Verification Procedures, except as modified below:

Formulate and submit to the Regional Materials Engineer a Polymer-Modified HMA design, which satisfies design criteria outlined in this specification. The minimum PG Binder content shall not be less than 6.0%.

6.3-mm Polymer-Modified HMA Design Control Points		
Standard Sieves (mm)	**Percent Passing Criteria**	
	Maximum	**Minimum**
9.5		100
6.30	100	90
4.75	90	---
2.36	70	37
0.075	10	2

6.3-mm Polymer-Modified HMA Mixture Additional Aggregate Criteria			
Coarse Aggregate Angularity (Percent), minimum	**Uncompacted Void Content of Fine Aggregate (Percent), minimum**	**Flat-and-elongated Particles (Percent), maximum**	**Sand Equivalent (Percent), minimum**
95/90	43	10	45

ITEM 402.06810118	**6.3-mm F1 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION**
ITEM 402.06811118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06810118**
ITEM 402.06820118	**6.3-mm F2 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION**
ITEM 402.06821118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06820118**
ITEM 402.06830118	**6.3-mm F3 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION**
ITEM 402.06831118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06830118**

6.3-mm Polymer-Modified HMA Volumetric Design Criteria			
% Gmm @ $N_{initial}$	**% Voids Filled with Binder**		**% Voids in the Mineral Aggregate, minimum**
	minimum	**maximum**	
< 90.5	70	78	16

6.3-mm Polymer-Modified HMA Design Number of Gyrations			
Compactive Effort	**Ninitial**	**Ndesign**	**Nmaximum**
Number of Gyrations	7	75	115

6.3-mm Polymer-Modified HMA Production Gradation Tolerances									
Sieve Size (mm)	**9.5**	**6.3**	**4.75**	**2.36**	**1.18**	**0.600**	**0.300**	**0.150**	**0.075**
Tolerance	± 4	± 4	± 3	± 3	± 3	± 2	± 2	± 2	± 2

1. Coarse Aggregate Type F1 Conditions

1. Limestone, dolomite, or a blend of the two having an acid insoluble residue content of not less than 20.0%

2. Sandstone, granite, chert, traprock, ore tailings, slag, or other similar noncarbonated materials

3. Use gravel or blend two or more of: gravel, limestone, dolomite, sandstone, granite, chert, traprock, ore tailings, or other similar materials to produce a final blend of which the noncarbonate plus 2.36-mm particles must comprise at least 30.0% of the total aggregate. In addition, at least 95.0% of the plus 4.75-mm particles must be noncarbonate.

2. Coarse Aggregate Type F2 Conditions

1. Limestone, dolomite, or a blend of the two having an acid insoluble residue content of not less than 20.0%

2. Sandstone, granite, chert, traprock, ore tailings, slag, or other similar noncarbonated materials

3. Use gravel or blend two or more of: gravel, limestone, dolomite, sandstone, granite, chert, traprock, ore tailings, or other similar materials to produce a final blend of which the noncarbonate plus 2.36-mm particles must comprise at least 10.0% of the total aggregate. In addition, at least 20.0% of the plus 4.75-mm particles must be noncarbonate.

3. Coarse Aggregate Type F3 Conditions

1. Limestone or a blend of limestone and dolomite having an acid insoluble residue content of not less than 20.0%

2. Dolomite

3. Sandstone, granite, chert, traprock, ore tailings, slag, or other similar noncarbonate materials

4. Use gravel or blend two or more of: gravel, limestone, dolomite, sandstone, granite, chert, traprock, ore tailings, or other similar materials to produce a final blend of which the noncarbonate plus 2.36-mm particles must comprise at least 10.0% of the total aggregate. In addition, at least 20.0% of the plus 4.75-mm particles must be noncarbonated.

PG Binder. Use the appropriate Performance-Graded Binder (PG Binder), as listed in the PG Binder Selection table below, in the production of these mixtures that meets AASHTO M 320 - Standard Specification for Performance-Graded Asphalt Binder. Elastic Recovery testing is to be preformed in accordance with ASTM D6084-04, Testing Procedure A, at 25°C on Rolling Thin Film Oven (RTFO) Binder Sample.

In addition, the PG Binder must meet the following requirements:

Upstate. Use of polyphosphoric acid (PPA) to modify PG binder properties is prohibited. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification. “Upstate” is defined as all other counties not listed in “Downstate”.

Downstate. Polyphosphoric (PPA) is the only type of acid allowed when PG binders are modified using acid. The use of PPA modified PG binder is prohibited for mixtures containing limestone, limestone as an aggregate blend component, limestone as a constituent in crushed gravel aggregate, or recycled asphalt pavement (RAP) that includes any limestone. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification. “Downstate” is defined as the counties of Orange, Rockland, Putnam, Westchester, Nassau, Suffolk, and the City of New York.

PG Binder Selection	
Location	PG Binder
Upstate [1]	PG 64-22 with a minimum of 60% Elastic Recovery
Downstate	PG 76-22 with a minimum of 60% Elastic Recovery

NOTES:
1. For Dutchess County “High Volume” roadways use the “Downstate” requirements. “High Volume is defined as 2 or 3 lane highways with design year two-way AADT over 8,000, or for more than three lanes, with two-way AADT over 13,000.

Other PG Binder grades allowed only with the approval of the Director of the Materials Bureau.

ITEM 402.06810118	**6.3-mm F1 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION**
ITEM 402.06811118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06810118**
ITEM 402.06820118	**6.3-mm F2 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION**
ITEM 402.06821118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06820118**
ITEM 402.06830118	**6.3-mm F3 POLYMER-MODIFIED HMA, 80 SERIES COMPACTION**
ITEM 402.06831118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06830118**

Reclaimed Asphalt Pavement (RAP). The maximum RAP blend portion is 20% by mass of the total mixture.

CONSTRUCTION DETAILS

The provisions of §401-3 and §402-3, Construction Details, will apply except as modified herein.

Use Item 407.02010018, *Tack Coat for 6.3-mm Polymer-Modified HMA*, as a tack coat.

Required Number of Passes by the Compaction Train [1]				
Pavement Course	Option 1 Three Roller Train (Static)		Option 2 Vibratory Rollers	
	Steel Wheel Roller Passes	Pneumatic Roller Passes	Vibratory Roller Passes	Static Roller Passes
6.3-mm Polymer-Modified HMA	4	2	2	2

1-These are recommended number of roller passes. Engineer-in-Charge may change the number of passes as needed.

Report the air void test values to the nearest 0.01 of a percent and aggregate gradation test values to the nearest 0.1 of a percent. When determining test result acceptability, the air void test value is referenced to the mix design median of 4.00 percent and the gradation test value is referenced to the Job Mix Formula (JMF) target value.

METHOD OF MEASUREMENT

The provisions of §401-4 and §402-4, Method of Measurement, shall apply except as modified herein.

When any material with plant air voids of less than 2% or greater than 6% which results in daily QAF of 0.85, the Engineer will evaluate the subject material to determine if it will be left in place. The considerations for determining whether the material in question is left in place are, but not limited to:

- Type of material produced.
- The layer in which the material was placed.
- The location of the project.

Use the Air Voids in Plant Mixture table to determine the Quality Adjustment Factor (QAF) in accordance with §401-4, Method of Measurement.

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ITEM 402.06831118	**PLANT PRODUCTION QUALITY ADJUSTMENT TO 402.06830118**

AIR VOIDS IN PLANT MIXTURE (Volumetric Designs)	
Average Absolute Value (Test Value - 4.0)	**Quality Adjustment Factor (QAF)**
0.00 - 0.17	1.05
0.18 - 0.33	1.04
0.34 - 0.50	1.03
0.51 - 0.67	1.02
0.68 - 0.83	1.01
0.84 - 1.00	1.00
1.01 - 1.10	0.99
1.11 - 1.20	0.98
1.21 - 1.30	0.97
1.31 - 1.40	0.96
1.41 - 1.50	0.95
1.51 - 1.60	0.94
1.61 - 1.70	0.93
1.71 - 1.80	0.92
1.81 - 1.90	0.91
1.91 - 2.00	0.90
over 2.00	0.85

Delivery Ticket Mix Coding[2]								
Mix Type	**Code**	**Code [1]**	**Design ESAL**	**Code**	**Consensus Properties**	**Code**	**PG Binder Type**	**Code**
6.3-mm	06	F1	**<30.0 million**	2	**<100 mm**	Y	**PG 64-22**	B
----	----	F2	----	----	----	----	**PG 76-22**	E
----	----	F3	----	----	----	----	----	----

Notes:

1. Friction Aggregate Classification Codes
2. Delivery Ticket Mix Coding Example: 6.3-mm, Type F2 friction requirements, PG 64-22 with a minimum of 60% Elastic Recovery - Mix Coding on Delivery Ticket: ***06F22YB***.

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BASIS OF PAYMENT

The provisions of §402-5 Basis of Payment shall apply.

Payment will be made under:

ITEM NO.	ITEM	PAY UNIT
402.06810118	6.3-mm F1 Polymer-Modified HMA, 80 Series Compaction	Metric Ton
402.06811118	Plant Production Quality Adjustment to 402.06810118	Quality Unit
402.06820118	6.3-mm F2 Polymer-Modified HMA, 80 Series Compaction	Metric Ton
402.06821118	Plant Production Quality Adjustment to 402.06820118	Quality Unit
402.06830118	6.3-mm F3 Polymer-Modified HMA, 80 Series Compaction	Metric Ton
402.06831118	Plant Production Quality Adjustment to 402.06830118	Quality Unit

Appendix F – PennDOT District 3-0

Thin Stone Matrix Asphalt (SMA)

SMA-Crumb Rubber Specification for Project SR 15
(District 3-0, PennDOT)

I. DESCRIPTION - This work is the RPS construction of plant-mixed HMA, type Stone Matrix Asphalt (SMA), on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor and utilizing Local Acceptance procedures. It is the Representative's sole discretion to switch between Local Acceptance Testing and MTD Testing, for any reason. Provide necessary personnel and equipment for local acceptance testing at the location from which the material is being supplied or at another location acceptable to the Representative. If the location, personnel or equipment is unacceptable to the Representative, acceptance testing will be performed at the MTD.

II. MATERIALS -

(a) Bituminous Material

1. Virgin Mix. 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 Bill of Lading for bituminous material on the first day of paving and when the batch number changes.

(b) Aggregate.

1. General Requirements. Provide aggregate from sources listed in Bulletin 14. Aggregate shall conform to the quality requirements for SMA Mixture Design as specified herein. 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 as follows: Use 100% crushed aggregate.

Determine Sand Equivalent Value in accordance with AASHTO T 176 and meet requirements of 45% minimum sand equivalent. Do not exceed 15% sodium sulfate soundness loss in 5 cycles.

3. Coarse Aggregate. Type A, Section 703.2, except as follows: use 100 % crushed stone, and meet the aggregate quality requirements of Table A below.

(c) Mineral Filler. Furnish mineral filler consisting of finely divided mineral matter such as rock or crushed limestone dust free of organic impurities. Furnish material with a maximum plasticity index of 4 and conforming to the grading requirements of AASHTO M 17. Submit a hydrometer analysis performed as specified in AASHTO T- 88 for mineral filler including the test number and the reference used to perform the analysis.

TABLE A
Aggregate Quality Requirements

Characteristic	Required Values
Abrasion, Max. %	30
Thin and Elongated Pieces. Max % ASTM D 4791 (measured on material retained on and above the 4.75 mm sieve). Criterion based upon maximum to minimum ratio. 3 to 1 5 to 1	 20 5
Absorption Max % AASHTO T 85	2.0
Crushed Fragments, Min. %	100 for one fracture face 90 for two fracture faces

(d) Stabilizer. Crumb Rubber Modifier (CRM) Additive, Recycled rubber derived from processing whole scrap tires or shredded tire materials taken from automobiles, trucks, or other equipment, provided that such processing does not produce, as a waste, casings or other round tire material that can hold water when sorted or disposed of above ground. Rubber tire buffings produced by the retreading process qualify as a source of crumb rubber. Furnish processed CRM from a manufacturer listed in Bulletin 15, certified as specified in Section 106.03(b)3., and meeting the following requirements:

Meet the following gradation as determined in accordance with ASTM D 5461-02, except using a 50 gram (1.76 oz) sample size with modified sieve stack below and max allowable loss 7.65%.

Sieve Size	Percent Passing
#8	98-100
#200	0-3

The same gradation CRM used to develop the Job Mix Formula shall be used during production.

The following tolerances shall be used to insure that the CRM used during production is similar to that used to develop the JMF.

Sieve Size	Percent Passing
#16	$\pm$ 10.0
#50	$\pm$ 5.0
#20	$\pm$ 2.0

Provide partially devulcanized CRM relatively free from fabric, wire, cord, and other contaminating materials, (maximum of 1.0% iron and 1.0% fiber by mass (weight) of total

CRM). Package CRM in sealed, low density polyethylene bags, having a melting point of less than 115 degrees C (240F). Fiber content shall be determined by weighing fiber balls, which are formed during the gradation test procedure.

Rubber particles shall be removed from the fiber balls before weighing. The metal content shall be determined by thoroughly passing a magnet through a 50 gram (1.76 oz) sample.

(e) Mixture Composition for RPS Construction.

1. Virgin Material Mixtures. Design and control SMA conforming to the requirements of AASHTO R35. Design an SMA mix that meets all Department requirements. Size, grade, and combine aggregate fractions in such proportions that the total aggregate and bitumen in the job-mix formula conform to the material, gradation, and volumetric requirements for the SMA mixture specified in Tables B and C. Do not use recycled asphalt pavement in the mix.

TABLE B
Mix Design Requirements for SMA Mixtures

AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING		
Sieve Size (mm)		4.75
9.5		100
4.75		90-100
2.36		28-65
1.18		
.600		
.300		
.150		
.075		8-15
VOLUMETRIC DESIGN REQUIREMENTS		
Design gyrations (N_{design})	100	
Voids in Mineral Aggregate	18.0 % Minimum	
Design air voids	3.5 - 4.0 %	
Minimum asphalt binder content	Table C	
Binder grade	PG 64-22	
Stabilizer content	0.5 to 1.0% by total mix weight	

TABLE C
Minimum Asphalt Binder Requirements for SMA Mixtures

Combined Aggregate Bulk Specific Gravity	Minimum Asphalt Content, % by Total Mix Weight
2.40	7.6
2.45	7.4
2.50	7.3
2.55	7.2
2.60	7.0
2.65	6.9
2.70	6.8
2.75	6.7
2.80	6.6
2.85	6.5
2.90	6.4
2.95	6.3
3.00	6.2

Note: Table C is based on a minimum asphalt binder content of 6.5% by volume; the values have been calculated using the following formula:

Minimum Asphalt Content = $16.13 / (0.1613 + 0.8434\ G_{sb}) + 0.2\%$

Where G_{sb} = bulk specific gravity of combined aggregate

Perform moisture sensitivity testing conforming to the requirements of AASHTO T-283, and include the freeze cycle.

Maintain results for both design and production as specified in Table B.

Design each SMA mix within the job-mix tolerances specified in Tables B and C. Test the materials, proportions, and the mixture at the HMA plant laboratory.

Submit a copy of each completed JMF, signed by a certified HMA Level 2 plant technician, to the District Materials Engineer (DME) 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. The Department reserves the right to review any SMA mix design through plant production, prior to using for Department work at no additional cost to the Department.

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

1.a Producer QC Plan. Section 409.2(e)1.a

1.b Plant Technicians. Section 409.2(e)1.b

1.c Annual JMF Verification. Section 409.2(e)1.c

1.d Production. Section 409.2(e)1.d

1.d.1 Apparent Moisture Content. Section 409.2(e)1.d.1

1.d.2 Asphalt Content. Section 409.2(e)1.d.2

1.d.3 Gradation. Section 409.2(e)1.d.3, except RAP is not permitted and produce the mix within the tolerances of Table D.

1.d.4 Theoretical Maximum Specific Gravity. Section 409.2(e)1.d.4

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 E. 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 R35.

TABLE D
Composition Tolerance Requirements of the Completed Mix

		Single Sample (n = 1)	**Multiple Samples (n ≥ 3)**
Gradation			
Passing 4.75 mm (No. 4) to 150 µm (No. 100) Sieves (Inclusive)		±4%	±3%
Passing 75 µm (No. 200) Sieve		±3.0%	±2.0%
Asphalt Content			
Bitumen		±0.6%	±0.4%
Temperature of Mixture (°C (F))			
Class of Material	**Type of Material**	**Minimum**	**Maximum**
PG 64-22	Asphalt Cement	130 (265)	160 (320)
Job-Mix Tolerance Requirements for Combined Hot Bin Gradations			
Gradation		**Single Sample (n = 1)**	
Passing 4.75 mm (No. 4) to 150 µm (No. 100) Sieves (Inclusive)		±4%	
Passing 75 µm (No. 200) Sieve		±3.0%	

TABLE E
Volumetric Tolerance Requirements of the Laboratory Compacted Mix

	Single Specimen (n = 1)	**Multiple Specimens (n ≥ 2)**
Air Voids at N_{design} (V_a)	±2.0% from JMF	±1.5% from JMF
Minimum VMA	18.0	_

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 4.75 mm (No. 4) sieve, the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table D.
- 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 D.
- QC test results on a single specimen (n=1) or on multiple specimens (n≥2) are not within the tolerances in Table E.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables D or E.

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 140 tonnes (150 tons) of production. If less than three samples are tested for mixture composition, determine conformance with Table D by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table D and the single and multiple specimen tolerances in Table E, 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 as specified in Section II.(e)1.d of this special provision.

(f) Mixture Acceptance.

1. General. The Department will accept the SMA mixture by lot acceptance as specified in Section III.(h)2 of this special provision.

2. Certification. SMA material will not be accepted by certification.

III. CONSTRUCTION -

(a) Paving Operation QC Plan. Section 409.3(a)

(b) Weather Limitations. Do not place SMA paving mixtures from October 1 to March 31 in Districts 1-0, 2-0 (except Juniata and Mifflin Counties), 3-0, 4-0, 5-0 (Monroe and Carbon Counties only), 9-0 (Cambria and Somerset Counties only), and 10-0; and from October 16 to March 31 in Districts 2-0 (Juniata and Mifflin Counties only), 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0 and 12-0. Exceptions require the written permission of the District Executive. Do not place bituminous paving mixtures when surfaces are wet or when the air or surface temperature is 10 °C (50F) 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.

(c) Bituminous Mixing Plant. Obtain SMA 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).

1. Stabilizer Supply System. Use a separate system for feeding stabilizing additives into the mixture. Provide the required proportion and uniform distribution of the stabilizing additive.

When a batch plant is used, add the stabilizer to the aggregate in the weigh hopper or acceptable method approved by the District Material Manager, and increase both dry and wet mixing times. Assure that the stabilizer is uniformly distributed prior to the injection of asphalt cement into the mixture. When a drum plant is used, add the stabilizer to the mixture in a manner that prevents the stabilizer from becoming in direct contact with the burner flame.

All stabilizer addition systems shall be approved by the Representative.

2. Hot-Mixture Storage. Ship material within one hour of plant mixing. Stored SMA material that does not consistently meet the same quality as material discharged directly into hauling vehicles will be rejected.

(d) Hauling Equipment. Section 409.3(d)

(e) Bituminous Pavers. Section 409.3(e)

(f) Rollers. Use a minimum of three static steel-wheeled rollers, each weighing a minimum of 10 tons and as specified in Section 108.05(c)3. Operate rollers according to manufacturer's recommendations. Use rollers equipped with a watering or soapy watering system that prevents material from sticking to the rollers. Do not use pneumatic wheeled rollers..

Do not use rollers in vibratory mode unless it can be demonstrated during the trial demonstration specified in Section III.(p) of this special provision and to the satisfaction of the Inspector in Charge that no detrimental effect to the pavement structure results from the vibration.

(g) Preparation of Existing Surface. Section 409.3(g)

(h) Spreading and Finishing.

1. General Requirements.

1.a Placing. Unless otherwise allowed, deliver, place, and compact SMA paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place SMA mixtures at the laying temperatures specified in Table D for the type and class of material used.

1.b Spreading and Finishing. Section 409.3(h)1.b and as follows: Plan and schedule operations to minimize hand work of SMA.

1.c Field Technician. Section 409.3(h)1.c

2. Mixture and Density Lot Acceptance (RPS Construction). Lot acceptance is required 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 one pavement core specimen which will serve as the acceptance specimen for both the mixture and density. Obtain pavement cores in accordance with Section 409.3(j)4.c. If density cores cannot be used for mixture acceptance, an additional core will be cut for mixture acceptance within 12 inches of the original core.

The details of lot and sublot determination, sample location selection and all testing are described in the Local Acceptance Directive (LAD) in effect at the time of paving. From each sublot, drill one 6-inch diameter core from the compacted surface as directed and in the Inspector's presence, as soon as possible but no later than the day following placement for testing to determine the percent compaction. Do not compress, bend, or distort samples during cutting, handling or transporting. If damage occurs, obtain replacement samples immediately within 1-foot of the original sample location, as directed by the Inspector. The Inspector will take possession of the samples immediately for packaging in accordance with the Quality Control Plan and for transport to the approved testing location.

Backfill, compact, and seal holes resulting from sampling with acceptable bituminous material within 24 hours after drilling.

The NECEPT certified HMA plant technician will test the samples in accordance with the Quality Control Plan and LAD to determine the percent compaction.

The Department will assign a Payment Factor Percentage for density in accordance with Section 409.4.

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 five days. If a lot is terminated due to a stoppage of five or more days, adjust the lot size and possibly number of sublots as specified in Section III.(h)2.a.1 of this special provision.

2.a.1 For JMF's placed in quantities less than 2250 tonnes (2,500 tons). Section 409.3(h)2.a.2.

2.b Mixture and Density Acceptance Samples. Section 409.3(j)4.c

2.c Mixture and Density Acceptance Sample Testing. MTD Testing will be utilized unless otherwise indicated in the proposal.

2.c.1 MTD Testing. The MTD will test the mixture and density acceptance samples first according to PTM No. 715, to determine the percent compaction. The Department will determine acceptance, with respect to density, as specified in Section IV.(a)3 of this special provision. If passing test results are obtained in regard to density, the MTD will then test the mixture and density 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 mm (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. The Department will accept the lot as specified in Section IV(a) of this special provision.

In the event that the density acceptance tests result in a defective lot, the samples will be retained until a determination is made in regard to retesting. Once any allowable retesting has occurred on density as outlined in Section 409.4(a)4.b, the samples will then be tested for mixture acceptance.

Stop all paving operations if any of the following conditions exist:

- cores are not taken within 1 day after placing the mixture
- the density for two consecutive lots or a total of three lots does not meet the density payment factor percentage of 100
- asphalt content is not within the single sample (n=1) or multiple sample ($n \geq 3$) tolerances in Table D for two consecutive lots or a total of three lots
- the percent passing the 75 mm (No. 200) sieve is not within the single sample (n=1) or multiple sample ($n \geq 3$) tolerances in Table D for two consecutive lots or a total of three lots

Determine the cause of the problem and provide a proposed solution to the Department. Do not resume paving until the Representative reviews the proposed solution and authorizes production to continue.

3. Flushing. Flushing is continuous or repeated areas of excess asphalt on the pavement surface. The Department will address flushing as follows:

3.a Evaluating Flushing. If the Representative observes flushing that may result in defective SMA pavement, then:

- The Inspector will notify the Contractor of the observed flushing.

- The Contractor may continue work at its own risk while it immediately and continually adjusts the operation to eliminate the flushing from future work.

3.b Test Section. If there is a visible flushing problem which continues as determined by the Representative then:

- Immediately suspend placing the SMA course. Evaluate the cause of flushing according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the SMA course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.
- Under the direction of the Representative, follow the procedures specified in Section III.(h)3.c of this special provision to determine if the flushing resulted in defective pavement.
- 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 flushing, 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 flushing 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 visible flushing and a minimum of three cores from the pavement representing an area with no visible flushing. 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 SMA flushing. 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 or if previously identified problematic aggregates are used in the mixture PTM No. 702, Modified Method D or other test method identified in the producer's QC Plan.

An area of visible flushing contains defective SMA 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 4.75mm (No. 4) sieve or 75 ?m (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 of defective pavement. Construct replacement pavement conforming to the appropriate surface tolerances as specified in Section 409.3(l). For SMA pavements not considered defective, the Department may still require surface corrections if the Representative determines that flushing results in a slippery surface condition.

(i) Compaction. Begin rolling material immediately after placement. Compact the SMA 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, pattern, and roller

size (and/or amplitude and frequency if vibratory rolling is approved by the Representative) to eliminate displacement, shoving, cracking, and aggregate breakage in accordance with Section III.(f) of this special provision. Satisfactorily correct displacement resulting from reversing roller directions and other causes. Complete compaction before the mixture temperature has cooled below 110 C (230 F).

Without using excess water, maintain wheels of steel wheel rollers moist and clean to prevent the mixture from adhering to the wheels.

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 SMA mixture and compact the mixture even with the surrounding pavement surface.

(j) Mat Density Acceptance.

1. General. The Department will accept the mixtures by lot acceptance as specified in Section III.(h)2 of this special provision. The acceptance criteria will be as given in Table F of this special provision. The Department will determine acceptance, with respect to density, as specified in Section IV of this special provision.

(k) Joints. Section 409.3(k)

(l) Surface Tolerance. Section 409.3(l)

(m) Tests for Depth: Binder and Wearing Courses. Section 409.3(m)

(n) Protection of Courses. Section 409.3(n)

(o) Defective Work. Section 409.3(o)

(p) Demonstration. Before proceeding with the actual work, demonstrate to the Representative that the proposed SMA mix can be produced, placed and compacted to meet the requirements of this special provision. Place a minimum of 100 tons outside the project limits for each trial demonstration. Simulate the hauling time for the demonstration. This work is incidental to the wearing course. If vibratory rolling is proposed, demonstrate to the satisfaction of the Inspector in Charge that no detrimental effect to the pavement structure results from the vibration. On projects where a limited amount of material is placed, the test strip may be waived or placed at a reduced tonnage at the discretion of the Representative.

IV. MEASUREMENT AND PAYMENT -

(a) SMA RPS Construction.

1. Stone Matrix Asphalt, HMA Wearing Course RPS. Square Meter (Square Yard) or Tonne (Ton)

2. Bituminous Tack Coat. Section 460.4.

3. Mixture and Density Acceptance by Lot Using Pavement Cores. The Department will pay on a lot-by-lot basis at the contract price, adjusted for Payment Factor Percentages as specified in Table F. 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 G.

3.a Payment. Section 409.4(a)4.a

3.b Retesting. Section 409.4(a)4.b

TABLE F
Contract 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 of % Asphalt by Weight	Acceptance sample test results are within ±0.6% for n=1 and ±0.4% for n?3*	100
		Percent Within Tolerance if the acceptance sample test results are not within one or both of the above listed tolerances.	Table H
Gradation			
All sizes	Acceptance Sample Testing of % Passing 75 ?m (No. 200) Sieve	Acceptance sample test results are within ±3.0% for n=1 and ±2.0% for n?3*	100
		Percent Within Tolerance if the acceptance sample test results are not within one or both of the above listed tolerances.	Table H
Mat Density			
All sizes	Acceptance Sample Testing of Pavement Cores	All individual results for the lot are ?92 % and <97 % of the maximum theoretical density	100
		Percent Within Tolerance if any individual sublot test result for the lot is not ³92 % and < 97 % of the maximum theoretical density.	Table H
* The Department may elect to randomly select and test only one sublot acceptance sample from			

each lot to determine conformance to the specifications. If only one sublot acceptance sample is tested, tighter tolerances than those in Table D will be used to determine 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 lots payment factor percentage will be determined according to this table. If the one sublot fails to meet the tighter tolerances, all acceptance samples from the lot will be tested to determine the payment factor percentage according to this table.

TABLE G
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, %	
All sizes	-0.4	+0.4
	Percent Passing the 75 µm (No. 200) sieve from JMF Value, %	
All sizes	-2.0	+2.0
	Mat Density*	
All sizes	0.92T	0.98T
* Where T = Current Maximum Theoretical Density, kg/m3 (lbs./cu. ft.)		

TABLE H
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 Engineer/Administrator, 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.

Appendix G – CD-ROM

Spreadsheet for Determination of Optimum Treatment Timing