

## SECTION 400 – ASPHALT PAVEMENTS

### SECTION 401 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HOT MIX ASPHALT, HMA, PAVEMENT

#### 401.01 Description

This work shall consist of one or more courses of QC/QA HMA base, intermediate, or surface mixtures constructed on prepared foundations in accordance with 105.03.

#### 401.02 Quality Control

- 10 The HMA shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Hot Mix Asphalt Producer Program. The HMA shall be transported and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing HMA paving operations.

When a safety edge is required for a project, the QCP shall identify the device or devices in accordance with 409.03(c) to be used for constructing the safety edge.

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## MATERIALS

#### 401.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials

PG Binder ..... 902.01(a)

Coarse Aggregates..... 904

Base Mixtures – Class D or Higher

Intermediate Mixtures – Class C or Higher

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Surface Mixtures\* – Class B or Higher

Fibers .....AASHTO M 325

Fine Aggregates..... 904

\*Surface aggregate requirements are listed in 904.03(d).

#### 401.04 Design Mix Formula

- 40 A design mix formula, DMF, shall be prepared in accordance with 401.05 and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture. The DMF shall state the calibration factor, test temperature, and absorption factors to be used for the determination of binder content using the ignition oven in accordance with ITM 586, the binder content by extraction in accordance with ITM 571, and a Mixture Adjustment Factor, MAF. The DMF shall state the source, type, and dosage rate of any stabilizing additives. Approval of the DMF will be based on the ESAL and mixture designation. A mixture number will be assigned by the Engineer. No mixture will be accepted until the DMF has been approved.

The ESAL category identified in the pay item correlates to the following ESAL ranges.

ESAL CATEGORY	ESAL
1	< 300,000
2	300,000 to < 3,000,000
3	3,000,000 to < 10,000,000
4	10,000,000 to < 30,000,000
5	≥ 30,000,000

50 The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 58-28, PG 64-22, PG 64-28 or PG 70-22 binders are used or 325°F whenever PG 70-28 or PG 76-22 binders are used. QC/QA HMA may be produced using a water-injection foaming device. The DMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture.

**401.05 Volumetric Mix Design**

The DMF shall be determined for each mixture from a volumetric mix design by a design laboratory selected from the Department’s list of approved Mix Design Laboratories. A volumetric mixture shall be designed in accordance with AASHTO 60 R 35 and the respective AASHTO reference as listed below.

Bulk Specific Gravity and Density of Compacted Asphalt  
 Mixtures Using Automatic Vacuum Sealing ..... AASHTO T 331

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation tables:

Dense Graded, Mixture Designation – Control Point (Percent Passing)					
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
Sieve Size					
50.0 mm					
37.5 mm	100.0				
25.0 mm	90.0 - 100.0	100.0			
19.0 mm	< 90.0	90.0 - 100.0	100.0		
12.5 mm		< 90.0	90.0 - 100.0	100.0	100.0
9.5 mm			< 90.0	90.0 - 100.0	95.0 - 100.0
4.75 mm				< 90.0	90.0 - 100.0
2.36 mm	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0*	
1.18 mm					30.0 - 60.0
600 μm					
300 μm					
75 μm	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	6.0 - 12.0
* The mix design gradation shall be less than or equal to the PCS control point for 9.5 mm category 3, 4 and 5 surface mixtures.					

PCS Control Point for Mixture Designation (Percent Passing)					
Mixture Designation	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
Primary Control Sieve	4.75 mm	4.75 mm	2.36 mm	2.36 mm	NA
PCS Control Point	40	47	39	47	NA

Open Graded, Mixture Designation – Control Point (Percent Passing)		
	OG19.0 mm	OG25.0 mm
Sieve Size		
37.5 mm		100.0
25.0 mm	100.0	70.0 – 98.0
19.0 mm	70.0 – 98.0	50.0 – 85.0
12.5 mm	40.0 – 68.0	28.0 – 62.0
9.5 mm	20.0 – 52.0	15.0 – 50.0
4.75 mm	10.0 – 30.0	6.0 – 30.0
2.36 mm	7.0 - 23.0	7.0 – 23.0
1.18 mm	2.0 – 18.0	2.0 – 18.0
600 µm	1.0 – 13.0	1.0 – 13.0
300 µm	0.0 – 10.0	0.0 – 10.0
150 µm	0.0 – 9.0	0.0 – 9.0
75 µm	0.0 – 8.0	0.0 – 8.0
% of Binder	> 3.0	> 3.0

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Dust/Calculated Effective Binder Ratio shall be taken from 0.6 to 1.2, when the aggregate gradation passes above the primary control sieve, PCS, control point and 0.8 to 1.6 when the aggregate gradation is less than or equal to the PCS. The Dust/Calculated Effective Binder Ratio for 4.75 mm mixtures shall be 0.9 to 2.0.

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The optimum binder content for dense graded mixtures shall produce 4.0% air voids at  $N_{des}$  and for open graded mixtures shall produce 15.0% – 20.0% air voids at  $N_{des}$ . The design for dense graded mixtures shall have at least four points, including a minimum of two points above and one point below the optimum. A one point design may be used for open graded mixtures. The maximum specific gravity shall be mass determined in water in accordance with AASHTO T 209. The bulk specific gravity of the gyratory specimens shall be determined in accordance with AASHTO T 166, Method A or AASHTO T 275, if required, for dense graded mixtures and AASHTO T 331 for open graded mixtures.

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The percent draindown of open graded mixtures shall not exceed 0.30% in accordance with AASHTO T 305. Open graded mixtures may incorporate recycled materials and fibers. The recycled materials shall be in accordance with 401.06, and the fiber type and minimum dosage rate shall be in accordance with AASHTO M 325. The binder for open graded mixtures may have the upper temperature classification reduced by 6°C from the specified binder grade if fibers are incorporated into the mixture or if a minimum of 3.0% reclaimed asphalt shingles by weight of the total mixture are used.

Dense graded mixture shall be tested for moisture susceptibility in accordance with AASHTO T 283 except that the loose mixture curing shall be replaced by mixture conditioning for 2 h in accordance with AASHTO R 30. The minimum tensile strength ratio, TSR, shall be 80%. The 6 in. mixture specimens shall be compacted in accordance with AASHTO T 312. If anti-stripping additives are added to the mixture to be in accordance with the minimum TSR requirements, the dosage rate shall be submitted with the DMF.

A PG binder grade or source change will not require a new mix design. If the upper temperature classification of the PG binder is lower than the original PG grade, a new TSR value is required.

The MAF equals the Gmm from the mixture design divided by the following: 2.465 for 9.5 mm mixtures and 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures. If the MAF calculation results in a value where  $0.980 \leq \text{MAF} \leq 1.020$ , then the MAF shall be considered to be 1.000. If the MAF is greater than 1.020, the calculated MAF value shall have 0.020 subtracted from the value. If the MAF is less than 0.980, the calculated MAF value shall have 0.020 added to the value. The MAF does not apply to OG mixtures.

Changes in the source or types of aggregates shall require a new DMF. A new DMF shall be submitted to the District Testing Engineer for approval one week prior to use.

The mixture design compaction temperature for the specimens shall be  $300 \pm 9^\circ\text{F}$  for dense graded mixtures and  $260^\circ\text{F}$  for open graded mixtures.

Design criteria for each mixture shall be based on the ESAL shown in the contract documents and shall be as follows:

GYRATORY COMPACTION EFFORT					
ESAL	$N_{ini}^*$	$N_{des}^*$	$N_{max}^*$	Max. % Gmm @ $N_{ini}$	Max. % Gmm @ $N_{max}$
DENSE GRADED					
< 300,000	6	50	75	91.5	98.0
300,000 to < 3,000,000	7	75	115	90.5	98.0
3,000,000 to < 10,000,000	8	100	160	89.0	98.0
10,000,000 to < 30,000,000	8	100	160	89.0	98.0
$\geq 30,000,000$	9	125	205	89.0	98.0
OPEN GRADED					
All ESAL	NA	20	NA	NA	NA
* $N_{ini}$ , $N_{des}$ , $N_{max}$ - definitions are included in AASHTO R 35					

VOIDS IN MINERAL AGGREGATE, VMA, CRITERIA @ N <sub>des</sub>	
Mixture Designation	Minimum VMA, %
4.75 mm	16.0
9.5 mm	15.0
12.5 mm	14.0
19.0 mm	13.0
25.0 mm	12.0
OG19.0 mm	NA
OG25.0 mm	NA

VOIDS FILLED WITH ASPHALT, VFA, CRITERIA @ N <sub>des</sub>	
ESAL	VFA, %
< 300,000	70 – 80
300,000 to < 3,000,000	65 – 78
3,000,000 to < 10,000,000	65 – 75
10,000,000 to < 30,000,000	65 – 75
≥ 30,000,000	65 – 75

Notes: 1. For 9.5 mm mixtures, the specified VFA range shall be 73% to 76% for design traffic levels ≥ 3 million ESALs.  
2. For 25.0 mm mixtures, the specified lower limit of the VFA shall be 67% for design traffic levels < 0.3 million ESALs.  
3. For 4.75 mm mixtures, the specified VFA range shall be 75% to 78% for design traffic levels ≥ 3 million ESALs.  
4. For OG19.0 mm and OG25.0 mm mixtures, VFA is not applicable.

#### 401.06 Recycled Materials

130 Recycled materials may consist of reclaimed asphalt pavement, RAP, or reclaimed asphalt shingles, RAS, or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. The RAP coarse aggregate shall pass the maximum size sieve for the mixture being produced and the RAS shall be 100% passing the 1/2 in. (12.5 mm) sieve. RAP for the ESAL category 3, 4 and 5 surface mixtures shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

140 Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. The amount of total binder replaced by binder in the recycled material shall be computed as follows:

$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E} \times 100\%$$

where:

A = RAP, % Binder Content

B = RAP, % in Mixture

401.06

C = RAS, % Binder Content

D = RAS, % in Mixture

150 E = Total, % Binder Content in Mixture

RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. Post-consumer asphalt shingles shall be in accordance with AASHTO MP 15 and prepared by a processing company with an IDEM Legitimate Use Approval letter. A copy of this letter shall be submitted to the Engineer. Deleterious material present in post-consumer asphalt shingles shall be limited to the percentages stated in AASHTO MP 15. Pre-consumer and post-consumer asphalt shingles shall not be blended for use in HMA mixtures and shall be stockpiled separately from other materials.

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The recycled material percentages shall be as specified on the DMF. HMA mixtures utilizing recycled materials shall be limited to the binder replacement percentages in the following table:

HMA mixtures utilizing RAP or RAS or a blend of RAP and RAS

MAXIMUM BINDER REPLACEMENT, %									
Mixture Category	Base and Intermediate					Surface			
	Dense Graded				Open Graded		Dense Graded		
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
1	40.0*				25.0		40.0*		
2	40.0*				25.0		40.0*		
3	40.0*				25.0		25.0		
4	40.0*				25.0		25.0		
5	40.0*				25.0		25.0		

\*RAS materials shall not contribute more than 25% by weight of the total binder content for any HMA mixture.

170 The combined aggregate properties shall be in accordance with 904. The combined aggregate bulk specific gravity shall be determined in accordance with ITM 584 and the combined aggregate gradation shall be in accordance with 401.05 for the HMA mixture specified.

HMA mixtures with a binder replacement less than or equal to 25.0% by weight of the total binder content by utilizing RAP or RAS or a blend of RAP and RAS materials shall use the specified binder grade.

180 HMA mixtures with a binder replacement greater than 25.0% and less than or equal to 40.0% by weight of the total binder content by utilizing RAP or a blend of RAP and RAS shall use a binder grade with upper and lower temperature classifications reduced by 6°C from the specified binder grade. RAS materials shall not contribute more than 25.0% by weight of the total binder content for any HMA mixture.

#### 401.07 Lots and Sublots

190 Lots will be defined as 5,000 t of base or intermediate mixtures or 3,000 t of surface mixture. Lots will be further sub-divided into sublots not to exceed 1,000 t of base or intermediate mixtures or 600 t of surface mixture. Partial sublots of 100 t or less will be added to the previous subplot. Partial sublots greater than 100 t constitute a full subplot. Partial lots of four sublots or less will be added to the previous lot, if available.

#### 401.08 Job Mix Formula

200 A job mix formula, JMF, shall be developed by a certified HMA producer. A JMF used in the current or previous calendar year that was developed to  $N_{des}$  will be allowed. The mixture compaction temperature shall be  $300 \pm 9^{\circ}\text{F}$  for dense graded mixtures and  $260 \pm 9^{\circ}\text{F}$  for open graded mixtures. The JMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture. The JMF for each mixture shall be submitted to the Engineer and shall use the same MAF as the DMF.

#### 401.09 Acceptance of Mixtures

210 Acceptance of mixtures for binder content, VMA at  $N_{des}$ , and air voids at  $N_{des}$  for each lot will be based on tests performed by the Engineer for dense graded mixtures with original contract pay item quantities greater than or equal to 300 t. Acceptance of mixtures for binder content and air voids at  $N_{des}$  will be based on a type D certification in accordance with 402.09 for dense graded mixtures with original contract pay item quantities less than 300 t. Acceptance of mixtures for binder content and air voids at  $N_{des}$  for each lot will be based on tests performed by the Engineer for open graded mixtures.

The Engineer will randomly select the location within each subplot for sampling in accordance with ITM 802. The first 300 t of the first subplot of the first lot for each mixture pay item will not be sampled. An acceptance sample will consist of plate samples obtained in accordance with ITM 802 and ITM 580. The Engineer will take immediate possession of the samples.

220 Acceptance samples will be reduced to the appropriate size for testing in accordance with ITM 587. The binder content will be determined in accordance with ITM 586 or ITM 571 as directed by the Engineer. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. The air voids will be determined in accordance with AASHTO R 35 based on the average bulk specific gravity from two gyratory specimens and the MSG for the subplot. The VMA will be determined in accordance with AASHTO R 35 based on the average bulk specific gravity from two gyratory specimens, the percent aggregate in the mixture from the subplot and the BSG of the aggregate blend from the DMF/JMF as applicable. The gyratory pills will be prepared in accordance with AASHTO T 312.

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230 The bulk specific gravity of gyratory specimens for dense graded mixtures will be determined in accordance with AASHTO T 166, Method A or AASHTO T 275, if required, except samples are not required to be dried overnight. The bulk specific gravity of gyratory specimens for open graded mixtures, OG19.0 mm, OG25.0 mm will be determined in accordance with AASHTO T 331.

A binder draindown test in accordance with AASHTO T 305 for open graded mixtures shall be completed once per lot in accordance with 401.07 and shall not exceed 0.50%.

240 The Engineer's acceptance test results for each subplot will be available after the subplot and testing are complete.

Air voids, binder content and VMA values will be reported to the nearest 0.01%. Draindown test results will be rounded to the nearest 0.01%. Rounding will be in accordance with 109.01(a).

250 Pay factors for dense graded mixtures with original contract pay item quantities greater than or equal to one lot will be determined in accordance with 401.19(a). Partial lots of four sublots or less will have pay factors determined in accordance with 401.19(b) if the previous lot is not available.

Pay factors for dense graded mixtures with original contract pay item quantities greater than or equal to 300 t and less than one lot and open graded mixtures will be determined in accordance with 401.19(b).

The Contractor may request an appeal of the Engineer's test results in accordance with 401.20.

260 Fibers incorporated into the mixture will be accepted on the basis of a type A certification for the specified material properties for each shipment of fibers. Fibers from different manufacturers and different types of fibers shall not be intermixed.

In the event that an acceptance sample is not available to represent a subplot, all test results of the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

## CONSTRUCTION REQUIREMENTS

### 401.10 General

270 Equipment for HMA operations shall be in accordance with 409. The Contractor shall submit to the Engineer written documentation that includes the manufacturer's make, model, serial number, manufactured year, and the manufacturer's literature with pictures. The documentation shall be submitted prior to use and shall certify that the paving equipment proposed for the project is new and includes the modifications or have been modified in accordance with the following.



The paver shall be equipped with means of preventing the segregation of the coarse aggregate particles when moving the mixture from the paver hopper to the paver augers. The means and methods used shall be in accordance with the paver manufacturer's instructions and may consist of chain curtains, deflector plates, or other such devices, or any combination of these.

The following specific requirements shall also apply to identified HMA pavers:

1. Blaw-Knox HMA pavers shall be equipped with the Blaw-Knox Materials Management Kit, MMK.
2. Cedarrapids HMA pavers shall be those that were manufactured in 1989 or later.
- 290 3. Barber-Green/Caterpillar HMA pavers shall be equipped with deflector plates as identified in the December, 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630-DFL, 6631-DFL, or 6640-DFL}".

The Contractor is also required to demonstrate to the Engineer prior to use, that the modifications to the paving equipment have been implemented on all pavers to be used on the project.

Fuel oil, kerosene, or solvents shall not be transported in open containers on equipment. Cleaning of equipment and small tools shall not be accomplished on the pavement or shoulder areas.

Segregation or flushing or bleeding of HMA mixtures will not be allowed. Corrective action shall be taken to prevent continuation of these conditions. Segregated or flushed or bleeding HMA mixtures shall be removed if directed. All areas showing an excess or deficiency of binder shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

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#### **401.11 Preparation of Surfaces to be Overlaid**

The subgrade shall be shaped to the required grade and sections, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Milling of an existing pavement surface shall be in accordance with 306. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

Prior to placing an open graded mixture, the underlying HMA course shall have a full width base seal applied in accordance with 415. The base seal materials shall be applied within three calendar days after all density cores in accordance with 401.16 have been obtained.

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401.12

Rubblized concrete pavements shall be primed in accordance with 405. PCCP, milled asphalt surfaces, and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

330 All partially completed sections of roadway that are 8 in. or less in thickness shall be proofrolled prior to the placement of additional materials unless otherwise directed by the Engineer. Proofrolling shall be accomplished in accordance with 203.26. The contact pressure shall be 70 to 80 psi. Soft yielding areas shall be removed and replaced.

#### **401.12 Process Control**

The Engineer and Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

#### **401.13 Weather Limitations**

340 HMA courses of less than 138 lb/sq yd shall be placed when the ambient temperature and the temperature of the surface on which it is to be placed is 45°F or above. No mixture shall be placed on a frozen subgrade.

#### **401.14 Spreading and Finishing**

350 The mixture shall be placed upon an approved surface by means of laydown equipment in accordance with 409.03(c). Prior to paving, both the planned quantity and lay rate shall be adjusted by multiplying by the MAF. When mixture is produced from more than one DMF or JMF for a given pay item, the MAF will be applied to the applicable portion of the mixture for each. The temperature of each mixture at the time of spreading shall not be more than 18°F below the minimum mixing temperature as shown on the JMF for mixtures compacted in accordance with 402.15.

Planned HMA courses greater than 220 lb/sq yd placed under traffic, shall be brought up even with each adjacent lane at the end of each work day. Planned HMA courses less than or equal to 220 lb/sq yd shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane. Traffic shall not be allowed on open graded mixtures.

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Hydraulic extensions on the paver will not be allowed for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving width varies. Hydraulic extensions may be used in tapers and added lanes less than 250 ft in length.

Automatic slope and grade controls shall be used as outlined in the QCP.

370 HMA mainline and HMA shoulders which are 8 ft or more in width shall be placed with paving equipment in accordance with 409.03(c)1.

When laying mixtures with density not controlled by cores, the speed of the paver shall not exceed 50 ft per minute. Rollers shall be operated to avoid shoving of the HMA and at speeds not to exceed 3 mph. However, vibratory rollers will be limited to 2.5 mph.

The finished thickness of any course shall be at least two times but not more than four times the maximum particle size as shown on the DMF.

380 A safety edge shall be constructed at locations where a dense graded intermediate mixture or a surface mixture is constructed adjacent to an aggregate or earth shoulder.

#### **401.15 Joints**

Longitudinal joints in the surface shall be at the lane lines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 6 in., and be located within 12 in. of the lane line.

390 Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course. For areas inaccessible to rollers, other mechanical devices shall be used to achieve the required density.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

#### **401.16 Density**

Acceptance will be based on lots and sublots in accordance with 401.07.

400 Density of the compacted dense graded mixture will be determined from cores except where:

- (a) the total planned lay rate to be placed over a shoulder existing prior to the contract award is less than 385 lb/sq yd; or
- (b) the first lift of material placed at less than 385 lb/sq yd over a shoulder existing prior to the contract award.

Density of any random core location in these areas will be assigned a value of 92.0% MSG and compaction shall be in accordance with 402.15.

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Open graded mixtures shall be compacted with six passes of a static tandem roller and will be assigned a value of 84.0% MSG. Vibratory rollers shall not be used on open graded mixtures.

Compaction of mixtures with original contract pay item quantities less than 300 t shall be in accordance with 402.15.

420 Density acceptance by cores will be based on samples obtained from two random locations selected by the Engineer within each subplot in accordance with ITM 802. One core shall be cut at each random location in accordance with ITM 580. The transverse core location will be located so that the edge of the core will be no closer than 3 in. from a confined edge or 6 in. from a non-confined edge of the course being placed. The maximum specific gravity will be determined from the samples obtained in 401.09.

430 The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6 in. diameter pavement sample. Coring shall be completed prior to the random location being covered by the next course. Surface courses shall be cored within two work days of placement. Damaged core shall be discarded and replaced with a core from a location selected by adding 1 ft to the longitudinal location of the damaged core using the same transverse offset.

The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than two times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

440 The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1 ft from the random location using the same transverse offset.

450 The density for the mixture will be expressed as the percentage of maximum specific gravity, % MSG, obtained by dividing the average bulk specific gravity by the maximum specific gravity for the subplot, times 100. Samples for the bulk specific gravity and maximum specific gravity will be dried in accordance with ITM 572. The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166, Method A or AASHTO T 275, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209.

Within one work day of coring operations the Contractor shall clean, dry, and refill the core holes with HMA of similar or smaller size particles.

The Engineer's acceptance test results for each subplot will be available when the subplot testing is complete. Acceptance of the pavement for density (% MSG) will be reported to the nearest 0.01%. Rounding will be in accordance with 109.01(a).

#### **401.17 Shoulder Corrugations**

Shoulder corrugations shall be in accordance with 606.

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**401.18 Pavement Smoothness**

Pavement smoothness will be accepted by means of a profilograph, a 16 ft long straightedge, or a 10 ft long straightedge as described below.

**(a) Profilograph**

When a pay item for Profilograph, HMA is included in the contract, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 912 on the mainline traveled way and ramps, including adjacent acceleration or deceleration lane, where all of the following conditions are met:

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1. The design speed is greater than 45 mph.
2. The traveled way or ramp lane width is constant and is 0.1 mi in length or longer.
3. The HMA is placed on a milled surface or the total combined planned lay rate of surface, intermediate, and base courses is 385 lb/sq yd or greater.

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The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor.

The project area, less paving exceptions and areas exempt from profilograph operation in accordance with ITM 912, will be divided into individual smoothness sections measuring 0.1 mi in length for each lane. Partial length smoothness sections adjacent to project limits, paving exceptions, or areas exempt from profilograph operation will be considered in accordance with ITM 912.

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If the original contract pay item quantity for a surface mixture is less than or equal to one subplot, the item will be exempt from profilograph operation and the smoothness will be accepted in accordance with 401.18(b).

If the posted speed limit for an entire smoothness section is less than or equal to 45 mph, the section will be exempt from profilograph operation and the smoothness within the section will be accepted in accordance with 401.18(b).

If the posted speed limit is greater than 45 mph for a portion of a smoothness section and is less than or equal to 45 mph for the remainder, the section smoothness acceptance will be as follows:

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1. By profilograph for the portion of the section with a posted speed limit greater than 45 mph.
2. In accordance with 401.18(b) for the portion of the section with a posted speed limit less than or equal to 45 mph.

At locations where the profilograph is required, it shall be used on the surface course and on any dense graded intermediate course immediately below the surface course.

**(b) 16 ft Straightedge and 10 ft Straightedge**

The Department will furnish and operate 16 ft and 10 ft straightedges as described below. The 16 ft straightedge is used to accept smoothness along the direction of mainline traffic and the 10 ft straightedge is used to accept smoothness transverse to the direction of mainline traffic. This includes longitudinal smoothness on public road approaches and median crossovers.

For contracts which include the Profilograph, HMA pay item, the 16 ft long straightedge will be used to accept longitudinal smoothness on surface courses at the following locations:

1. All mainline traveled way lanes shorter than 0.1 mi.
2. All mainline traveled way lanes within smoothness sections with posted speed limits less than or equal to 45 mph throughout the entire section length.
3. All mainline traveled way lanes at locations exempted from profilograph operation in accordance with ITM 912.
4. All tapers.
5. All turn lanes, including bi-directional left turn lanes.
6. All ramps with design speeds of 45 mph or less.
7. All acceleration and deceleration lanes associated with ramps with design speeds of 45 mph or less.
8. All shoulders.

For contracts where the profilograph is not used for smoothness acceptance, the 16 ft straightedge will be used to accept longitudinal smoothness on all dense graded courses at the above locations as well as all mainline travel way lanes and ramps with design speeds of greater than 45 mph. Smoothness acceptance on ramp acceleration or deceleration lanes will also be based on operation of the 16 ft straightedge.

The 10 ft long straightedge shall be used to check transverse slopes, across travel lanes and shoulders, approaches, and crossovers.

### (c) Smoothness Correction

At locations where the profilograph is being used on an intermediate course, all areas having a high or low point deviation in excess of 0.3 in. shall be corrected. After corrective action is taken on an intermediate course, a 16 ft straightedge may be used to verify the adequacy of the corrective action.

560 At locations where the profilograph is being used on a surface course, all areas having a high or low point deviation in excess of 0.3 in. shall be corrected. All smoothness sections with a deficient profile index in accordance with 401.19(c) shall be corrected. Underlying courses that are exposed by corrective action shall be milled to a depth of 1 1/2 in and replaced with surface course. After the corrective action is taken on a surface course, the profilograph shall be operated throughout the entire affected smoothness section to verify the adequacy of the corrective action.

570 At locations where the 16 ft straightedge is used, the pavement variations shall be corrected to 1/4 in. or less. When the 10 ft straightedge is used, the pavement variations shall be corrected to 1/8 in. or less.

If grinding of an intermediate course is used for pavement smoothness corrections, the grinding shall not precede the surface placement by more than 30 calendar days if open to traffic.

## 401.19 Pay Factors

### (a) Dense Graded Mixture $\geq$ One Lot

580 Pay factors, PF, are calculated for binder content, air voids at  $N_{des}$ , VMA at  $N_{des}$  and in-place density, % Gmm. The Percent Within Limits, PWL, for each lot will be determined in accordance with ITM 588. The appropriate pay factor for each property is calculated as follows:

Estimated PWL greater than 90:

$$PF = (105.00 - 0.50 \times (100.00 - PWL)) / 100$$

Estimated PWL greater than or equal to 50 and equal to or less than 90:

$$PF = (100.00 - 0.000020072 \times (100.00 - PWL)^{3.5877}) / 100$$

590

If the Lot PWL for any one of the properties is less than 50 or a subplot has an air void content less than 1.0% or greater than 7.0%, the lot will be referred to the Office of Materials Management for adjudication as a failed material in accordance with normal Department practice as listed in 105.03.

Binder content, air voids, VMA, and in-place density, % Gmm, PF values will be reported to the nearest 0.01. Rounding will be in accordance with 109.01(a).

401.19

600 A composite pay factor for each lot based on test results for mixture properties and density is determined by a weighted formula as follows:

$$\text{Lot PF} = 0.20(\text{PF}_{\text{BINDER}}) + 0.35(\text{PF}_{\text{VOIDS}}) + 0.10(\text{PF}_{\text{VMA}}) + 0.35(\text{PF}_{\text{DENSITY}})$$

where:

Lot PF = Lot Composite Pay Factor for Mixture and Density

PF<sub>BINDER</sub> = Lot Pay Factor for Binder Content

PF<sub>VOIDS</sub> = Lot Pay Factor for Air Voids at N<sub>des</sub>

PF<sub>VMA</sub> = Lot Pay Factor for VMA at N<sub>des</sub>

PF<sub>DENSITY</sub> = Lot Pay Factor for In-Place Density, % Gmm

610

The lot quality assurance adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (\text{Lot PF} - 1.00) / \text{MAF}$$

where:

q = quality assurance adjustment for mixture properties and density of the lot

L = Lot quantity

U = Unit price for the material, \$/ton

620

Lot PF = Lot Pay Factor

Lot test results for binder content, air voids, VMA, and density will be used to determine the Lot Pay Factors.

The specification limits for binder content, air voids at N<sub>des</sub>, VMA at N<sub>des</sub>, and density will be as follows:

SPECIFICATION LIMITS				
MIXTURE				
	LSL*		USL**	
Binder Content, %	- 0.40 from JMF		+ 0.40 from JMF	
Air Voids at N <sub>des</sub> , %	2.60		5.40	
Voids In Mineral Aggregate at N <sub>des</sub> , %	Greater of		Lesser of	
	Spec - 0.50	JMF - 1.20	Spec + 2.00	JMF + 1.20
DENSITY				
	LSL*		USL**	
Roadway Core Density (% Gmm), %	91.00		NA	
* LSL, Lower Specification Limit				
** USL, Upper Specification Limit				

**(b) Dense Graded Mixture < One Lot and Open Graded Mixture**

630

A composite pay factor for each subplot based on test results for mixture properties and density is determined in a weighted formula as follows:



$$SCPF = 0.20(PF_{\text{BINDER}}) + 0.35(PF_{\text{VOIDS}}) + 0.10(PF_{\text{VMA}}) + 0.35(PF_{\text{DENSITY}})$$

where:

SCPF = Sublot Composite Pay Factor for Mixture and Density

$PF_{\text{BINDER}}$  = Sublot Pay Factor for Binder Content

$PF_{\text{VOIDS}}$  = Sublot Pay Factor for Air Voids at  $N_{\text{des}}$

$PF_{\text{VMA}}$  = Sublot Pay Factor for VMA at  $N_{\text{des}}$

640

$PF_{\text{DENSITY}}$  = Sublot Pay Factor for Density

If the SCPF for a sublot is less than 0.85, the Office of Materials Management will evaluate the pavement. If the Contractor is not required to remove the mixture, quality assurance adjustments of the lot will be assessed or other corrective actions taken as determined by the Office of Materials Management.

The sublot quality assurance adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (SCPF - 1.00) / \text{MAF}$$

650 where:

q = quality assurance adjustment for the sublot

L = sublot quantity

U = unit price for the material \$/ton

SCPF = sublot composite pay factor

Sublot test results for mixture properties will be assigned pay factors in accordance with the following:

BINDER CONTENT		
Dense Graded	Open Graded	Pay Factor
Deviation from JMF ( $\pm$ %)	Deviation from JMF ( $\pm$ %)	
$\leq 0.2$	$\leq 0.2$	1.05
0.3	0.3	1.04
0.4	0.4	1.02
0.5	0.5	1.00
0.6	0.6	0.90
0.7	0.7	0.80
0.8	0.8	0.60
0.9	0.9	0.30
1.0	1.0	0.00
$> 1.0$	$> 1.0$	Submitted to the Office of Materials Management*

\* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

VMA		
Dense Graded	Open Graded	Pay Factor
Deviation from JMF ( $\pm$ %)	Deviation from JMF ( $\pm$ %)	
$\leq 0.5$		1.05
$> 0.5$ and $\leq 1.0$	All	1.00
$> 1.0$ and $\leq 1.5$		0.90
$> 1.5$ and $\leq 2.0$		0.70
$> 2.0$ and $\leq 2.5$		0.30
$> 2.5$		Submitted to the Office of Materials Management*

\* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

AIR VOIDS		
Dense Graded	Open Graded	Pay Factor
Deviation from JMF ( $\pm$ %)	Deviation from JMF ( $\pm$ %)	
$\leq 0.5$	$\leq 1.0$	1.05
$> 0.5$ and $\leq 1.0$	$> 1.0$ and $\leq 3.0$	1.00
1.1	3.1	0.98
1.2	3.2	0.96
1.3	3.3	0.94
1.4	3.4	0.92
1.5	3.5	0.90
1.6	3.6	0.84
1.7	3.7	0.78
1.8	3.8	0.72
1.9	3.9	0.66
2.0	4.0	0.60
$> 2.0$	$> 4.0$	Submitted to the Office of Materials Management*

\* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

For mixtures produced during a plant's adjustment period, pay factors based on the JMF with the above tolerances will be used to compute quality assurance adjustments.

Sublot test results for density will be assigned pay factors in accordance with the following:

670

DENSITY		
Percentages are based on %MSG		Pay Factors, %
Dense Graded	Open Graded	
≥ 97.0		Submitted to the Office of Materials Management*
95.6 - 96.9		1.05 - 0.01 for each 0.1% above 95.5
94.0 - 95.5		1.05
93.1 - 93.9		1.00 + 0.005 for each 0.1% above 93.0
92.0 - 93.0	84.0	1.00
91.0 - 91.9		1.00 - 0.005 for each 0.1% below 92.0
90.0 - 90.9		0.95 - 0.010 for each 0.1% below 91.0
89.0 - 89.9		0.85 - 0.030 for each 0.1% below 90.0
≤ 88.9		Submitted to the Office of Materials Management*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.		

The pay factors will be rounded to the nearest 0.01.

### (c) Smoothness

Smoothness pay adjustments will only be applied when the smoothness is measured by a profilograph. The pay adjustment will be based on the profile index generated on the surface course only.

680 At locations where a profilograph is used to accept smoothness, a quality assurance adjustment will be determined for each 0.1 mile section of each lane. This adjustment will be applied to all QC/QA HMA pay items within the pavement section. The adjustment for each section will be calculated using the following formula:

$$q_s = (PF_s - 1.00) \sum_{i=1}^n \left( A \times \frac{S}{T} \times U \right)$$

where:

690  $q_s$  = quality assurance adjustment for smoothness for one section  
 $PF_s$  = pay factor for smoothness  
 $n$  = number of layers  
 $A$  = area of the section, sq yd

401.19

S = planned spread rate for material, lb/sq yd

T = conversion factor: 2,000 lb/ton

U = unit price for the material, \$/ton

710 For smoothness sections that are less than 0.1 mile in length or require profilograph operation along both lane edges, the profile index used to obtain the smoothness pay factor used in the above formula will be determined in accordance with ITM 912.

The quality assurance adjustment for smoothness,  $Q_s$ , for the contract will be the total of the quality assurance adjustments for smoothness,  $q_s$ , on each section by the following formula:

$$Q_s = \sum q_s$$

710 When smoothness is measured by a profilograph, payment adjustments will be made based on a zero blanking band on the final profile index in accordance with the following table. Regardless of the tabulated value, the maximum pay factor for a smoothness section where corrective action has been performed will be 1.00.

PAY FACTORS FOR SMOOTHNESS (PI <sub>0.0</sub> ) ZERO BLANKING BAND	
Design Speed Greater than 45 mph	
Profile Index in./0.1 mi.	Pay Factor, PFs
Over 0.00 to 1.20	1.06
Over 1.20 to 1.40	1.05
Over 1.40 to 1.60	1.04
Over 1.60 to 1.80	1.03
Over 1.80 to 2.00	1.02
Over 2.00 to 2.40	1.01
Over 2.40 to 3.20	1.00
Over 3.20 to 3.40	0.96
All pavement with a profile index (PI <sub>0.0</sub> ) greater than 3.40 in. shall be corrected to a profile index less than or equal to 3.40 in.	

The total quality assurance adjustment is calculated as follows:

$$Q = Q_s + (\sum q)$$

where:

720 Q = total quality assurance adjustment  
 $Q_s$  = quality assurance adjustment for smoothness  
q = lot or subplot quality assurance adjustment

### 401.20 Appeals

730 If the QC test results do not agree with the acceptance test results, a request, along with the QC test results, may be made in writing for additional testing. The appeal sample will be analyzed in a lab different than the lab that analyzed the original sample when requested by the Contractor. Additional testing may be requested for one or more of the following tests: MSG, BSG of the gyratory specimens, binder content, or BSG of the density cores. The request for the appeal for MSG, BSG of gyratory specimens, binder content or BSG of the density cores shall be submitted within seven calendar days of receipt of the Department's written results for the lot accepted under 401.19(a) or the subplot accepted under 401.19(b). The subplot and specific test(s) shall be specified at the time of the appeal request. Only one appeal request per lot for mixture accepted under 401.19(a) or subplot for mixture accepted under 401.19(b) is allowed. Upon approval of the appeal, the Engineer will perform additional testing as follows.

740 The backup or new sample will be tested in accordance with the applicable test method for the test requested.

#### (a) MSG

The backup MSG will be dried in accordance with ITM 572 and mass determined in water in accordance with AASHTO T 209.

#### (b) BSG of the Gyratory Specimen

New gyratory specimens will be prepared and tested in accordance with AASHTO T 312 from the backup sample.

#### 750 (c) Binder Content

The backup binder content sample will be prepared and tested in accordance with the test method that was used for acceptance or as directed by the Engineer.

#### (d) BSG of the Density Core

760 Additional cores shall be taken within seven calendar days unless otherwise directed. Additional core locations will be determined by adding 1 ft longitudinally of the cores tested using the same transverse offset. The appeal density cores will be dried in accordance with ITM 572 and tested in accordance with AASHTO T 166, Method A or AASHTO T 275, if required.

The appeal results will replace all previous test result for acceptance of mixture in accordance with 401.09 and density in accordance with 401.16. The results will be furnished to the Contractor.

### 401.21 Method of Measurement

HMA mixtures will be measured by the ton of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

401.22

770 Milled shoulder corrugations will be measured in accordance with 606.02.

**401.22 Basis of Payment**

The accepted quantities for this work will be paid for at the contract unit price per ton for QC/QA-HMA, of the type specified, complete in place.

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made at the contract lump sum price for profilograph, HMA.

780 Adjustments to the contract payment with respect to mixture, density, and smoothness for mixture produced will be included in a quality adjustment pay item in accordance with 109.05.1.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment will be made under:

	<b>Pay Item</b>	<b>Pay Unit Symbol</b>
790	Profilograph, HMA.....	LS
	QC/QA-HMA, _____, _____, _____mm .....	TON
	(ESAL <sup>(1)</sup> ) (PG <sup>(2)</sup> ) (Course <sup>(3)</sup> ) (Mix <sup>(4)</sup> )	

- (1) ESAL Category as defined in 401.04
- (2) Number represents the high temperature binder grade. Low temperature grades are - 22
- (3) Surface, Intermediate, or Base
- (4) Mixture Designation

800 Preparation of surfaces to be overlaid shall be included in the cost of other pay items.

Coring and refilling of the core holes shall be included in the cost of other pay items within this section.

No payment will be made for additional anti-stripping additives, appeal coring or traffic control expenditures related to coring operations.

810 **The cost of removing and replacing soft and yielding areas shall be included in the cost of other pay items in this section.**

Corrections for pavement smoothness shall be included in the cost of other pay items within this section.

The price for Profilograph, HMA will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

If QC/QA-HMA intermediate over QC/QA-HMA base mixtures are specified, QC/QA-HMA intermediate mixture may be considered as a substitute for the QC/QA-HMA intermediate and QC/QA-HMA base mixtures upon a written request by the Contractor. The request for the substitution shall be prepared in advance of the work. A computation will be made in order to obtain a unit price for the QC/QA-HMA intermediate mixture. The quantity and amount for QC/QA-HMA intermediate mixture shall equal the sum of the contract quantities and amounts shown for QC/QA-HMA intermediate and QC/QA-HMA base mixtures. The unit price for QC/QA-HMA intermediate mixture shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the QC/QA-HMA intermediate mixture will be made at the unit price per ton for QC/QA-HMA intermediate mixture. No payment will be made for additional work or costs which may result due to this change.

## SECTION 402 – HOT MIX ASPHALT, HMA, PAVEMENT

### 402.01 Description

This work shall consist of one or more courses of miscellaneous mixtures constructed in accordance with 105.03.

### 402.02 Quality Control

The HMA shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Hot Mix Asphalt Producer Program. The HMA shall be transported and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing HMA paving operations.

When a safety edge is required for a project, the QCP shall identify the device or devices in accordance with 409.03(c) to be used for constructing the safety edge.

## MATERIALS

### 402.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials	
PG Binder .....	902.01(a)
Coarse Aggregates.....	904
Base Mixtures, – Class D or Higher	
Intermediate Mixtures – Class C or Higher	
Surface Mixtures* – Class B or Higher	
Fine Aggregates.....	904

\* Surface aggregate requirements are listed in 904.03(d).

#### 402.04 Design Mix Formula

A DMF shall be prepared in accordance with 402.05 and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture, the calibration factor and test temperature to be used for the determination of binder content using ITM 586 or ITM 571, and a MAF. Approval of the DMF will be based on the ESAL and mixture designation as follows.

Mixture Type	Type A	Type B	Type C	Type D
Design ESAL	200,000	2,000,000	9,000,000	11,000,000
Surface	4.75 mm	4.75 mm	4.75 mm	4.75 mm
	9.5 mm	9.5 mm	9.5 mm	9.5 mm
	12.5 mm	12.5 mm	12.5 mm	12.5 mm
Surface – PG Binder	64-22	64-22	70-22	70-22
Intermediate	9.5 mm	9.5 mm	9.5 mm	9.5 mm
	12.5 mm	12.5 mm	12.5 mm	12.5 mm
	19.0 mm	19.0 mm	19.0 mm	19.0 mm
	25.0 mm	25.0 mm	25.0 mm	25.0 mm
Intermediate – PG Binder	64-22	64-22	64-22	70-22
Base	19.0 mm	19.0 mm	19.0 mm	19.0 mm
	25.0 mm	25.0 mm	25.0 mm	25.0 mm
Base – PG Binder	64-22	64-22	64-22	64-22

40

Surface 4.75 mm mixtures shall not be used when the required lay rate shown on the plans is greater than 100 lb/sq yd. Surface 12.5 mm mixtures shall not be used when the required lay rate shown on the plans is less than 195 lb/sq yd.

The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 58-28, PG 64-22, PG 64-28 or PG 70-22 binders are used or 325°F whenever PG 70-28 or PG 76-22 binders are used. HMA may be produced using a water-injection foaming device. The DMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture.

50

The Engineer will assign a mixture number. No mixture will be accepted until the DMF has been approved.

#### 402.05 Volumetric Mix Design

The DMF shall be determined for each mixture from a volumetric mix design in accordance with 401.05.

A DMF developed for a QC/QA HMA mixture may be used and the source or grade of the binder may be changed; however, the high temperature grade shall meet the minimum requirements of 402.04.

60

The MAF equals the  $G_{mm}$  from the mixture design divided by the following: 2.465 for 9.5 mm mixtures and 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures.



If the MAF calculation results in a value where  $0.980 \leq \text{MAF} \leq 1.020$ , then the MAF shall be considered to be 1.000. If the MAF is greater than 1.020, the calculated MAF value shall have 0.020 subtracted from the value. If the MAF is less than 0.980, the calculated MAF value shall have 0.020 added to the value.

#### 402.06 Job Mix Formula

70 The job mix formula, JMF, shall be an approved JMF in accordance with 401.08 of the same gyratory compaction effort ESAL category or higher, and submitted in a format acceptable to the Engineer and shall use the same MAF as the DMF. The JMF shall state the maximum particle size in the mixture and the calibration factor and test temperature to be used for the determination of binder content using the ignition oven. Approval of the JMF will be based on the ESAL and mixture designation. No mixture will be accepted until the JMF has been approved.

All changes in the type or source of aggregate shall require the submittal of a new DMF for approval.

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#### 402.07 Mix Criteria

##### (a) Composition Limits for HMA Rumble Strip Mixtures

Rumble strip mixtures shall be type A surface in accordance with 402.04. A MAF in accordance with 402.05 will not apply. Aggregate requirements of 904.03(d) do not apply.

##### (b) Composition Limits for HMA Wedge and Leveling Mixtures

90 The mixture shall consist of surface or intermediate mixtures in accordance with 402.04. Aggregate requirements of 904.03(d) do not apply when the wedge and leveling mixture is covered by a surface or intermediate mixture.

##### (c) Composition Limits for Temporary HMA Mixtures

Temporary HMA mixtures shall be the type specified in accordance with 402.04. A MAF in accordance with 402.05 will not apply.

##### (d) Composition Limits for HMA Curbing Mixes

100 The mixture shall be HMA surface type A in accordance with 402 except 402.05 shall not apply and RAP shall not be used. The binder content shall be 7.0% and the gradations shall meet the following.

HMA Curbing Gradations	
Sieve Size	Percent Passing
1/2 in. (12.5 mm)	100.0
3/8 in. (9.5 mm)	80.0 - 100.0
No. 4 (4.75 mm)	73.0 ± 5.0
No. 30 (600 µm)	20.0 - 50.0
No. 200 (75 µm)	6.0 - 12.0

A DMF shall be prepared in accordance with the above table and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the calibration factor and test temperature to be used for the determination of binder content using ITM 586 or ITM 571.

#### 402.08 Recycled Materials

110 Recycled materials may consist of reclaimed asphalt pavement, RAP, or reclaimed asphalt shingles, RAS or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. The RAP coarse aggregate shall pass the maximum size sieve for the mixture being produced and the RAS shall be 100% passing the 1/2 in. (12.5 mm) sieve. RAP for the type C and D surface mixtures shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

120 Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. The amount of total binder replaced by binder in the recycled material shall be computed as follows:

$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E} \times 100\%$$

where:

- A = RAP, % Binder Content
- B = RAP, % in Mixture
- C = RAS, % Binder Content
- D = RAS, % in Mixture
- E = Total, % Binder Content in Mixture

130

RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. Post-consumer asphalt shingles shall be in accordance with AASHTO MP 15 and prepared by a processing company with an IDEM Legitimate Use Approval letter. A copy of this letter shall be submitted to the Engineer. Deleterious material present in post-consumer asphalt shingles shall be limited to the percentages stated in AASHTO MP 15. Pre-consumer and post-consumer asphalt shingles shall not be blended for use in HMA mixtures and shall be stockpiled separately from other materials.

140

The recycled material percentages shall be as specified on the DMF. HMA mixtures utilizing recycled materials shall be limited to the binder replacement percentages in the following table:

## HMA mixtures utilizing RAP or RAS or a blend of RAP and RAS

Maximum Binder Replacement, %							
Mixture Category	Base and Intermediate				Surface		
	Dense Graded				Dense Graded		
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	12.5 mm	9.5 mm	4.75 mm
A	40.0*				40.0*		
B	40.0*				40.0*		
C	40.0*				25.0		
D	40.0*				25.0		

\*RAS materials shall not contribute more than 25% by weight of the total binder content for any HMA mixture.

The combined aggregate properties shall be in accordance with 904. The combined aggregate bulk specific gravity shall be determined in accordance with ITM 584 and the combined aggregate gradation shall be in accordance with 401.05 for the HMA mixture specified.

HMA mixtures with a binder replacement less than or equal to 25.0% by weight of the total binder content by utilizing RAP or RAS or a blend of RAP and RAS materials shall use the specified binder grade.

HMA mixtures with a binder replacement greater than 25.0% and less than or equal to 40.0% by weight of the total binder content by utilizing RAP or a blend of RAP and RAS shall use a binder grade with upper and lower temperature classifications reduced by 6°C from the specified binder grade. RAS materials shall not contribute more than 25.0% by weight of the total binder content for any HMA mixture.

#### 402.09 Acceptance of Mixtures

Acceptance of mixtures will be in accordance with the Frequency Manual on the basis of a type D certification in accordance with 916. The test results shown on the certification shall be the quality control tests representing the material supplied and include air voids and binder content. Air voids tolerance shall be  $\pm 1.5\%$  and binder content tolerance shall be  $\pm 0.7\%$  from DMF or JMF.

Single test values and averages will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

Test results exceeding the tolerance limits will be considered as a failed material and adjudicated in accordance with 105.03.

### CONSTRUCTION REQUIREMENTS

#### 402.10 General

Equipment for HMA operations shall be in accordance with 409. The Contractor

402.11

shall submit to the Engineer prior to use a written Certificate of Compliance that the proposed paving equipment has been modified in accordance with 401.10 or is new and includes the modifications.

Fuel oil, kerosene, or solvents shall not be transported in open containers on any equipment at any time. Cleaning of equipment and tools shall not be accomplished on the pavement or shoulder areas.

190 Segregation, flushing or bleeding of HMA mixtures will not be allowed. Corrective action shall be taken to prevent continuation of these conditions. Areas of segregation, flushing or bleeding shall be corrected, if directed. All areas showing an excess or deficiency of asphalt materials shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

Mixture shall not be dispatched from the plant that cannot be spread and compacted before sundown of that day, unless otherwise specified.

200 **402.11 Preparation of Surfaces to be Overlaid**

The subgrade shall be shaped to the required grade and sections, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Milling of an existing surface shall be in accordance with 306. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

210 Prior to placing an open graded mixture, the underlying HMA course shall have a full width base seal applied in accordance with 415. The base seal materials shall be applied within three calendar days upon completion of paving the underlying HMA course.

Compacted aggregate bases and rubblized bases shall be primed in accordance with 405. PCCP, milled asphalt surfaces, and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

**402.12 Weather Limitations**

220 HMA courses less than 110 lb/sq yd are to be placed when the ambient and surface temperatures are 60°F or above. HMA courses equal to or greater than 110 lb/sq yd but less than 220 lb/sq yd are to be placed when the ambient and surface temperatures are 45°F or above. HMA courses equal to or greater than 220 lb/sq yd and HMA curbing are to be placed when the ambient and surface temperatures are 32°F or above. Mixture shall not be placed on a frozen subgrade. However, HMA courses may be placed at lower temperatures, provided the density of the HMA course is in accordance with 402.16.

230 All partially completed sections of roadway that are 8 in. or less in thickness shall be proofrolled prior to the placement of additional materials unless otherwise directed by the Engineer. Proofrolling shall be accomplished in accordance with 203.26. The contact pressure shall be 70 to 80 psi. Soft yielding areas shall be removed and replaced.

#### 402.13 Spreading and Finishing

240 The mixture shall be placed upon an approved surface by means of laydown equipment in accordance with 409.03(c). Prior to paving, both the planned quantity and lay rate shall be adjusted by multiplying by the MAF. When mixture is produced from more than one DMF or JMF for a given pay item, the MAF will be applied to the applicable portion of the mixture for each. Mixtures in areas inaccessible to laydown equipment or mechanical devices may be placed by other methods.

The temperature of each mixture at the time of spreading shall not be more than 18°F below the minimum mixing temperature as shown on the DMF or JMF.

250 Planned HMA courses greater than 220 lb/sq yd placed under traffic shall be brought up even with each adjacent lane at the end of each work day. Planned HMA courses less than or equal to 220 lb/sq yd shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane. Traffic shall not be allowed on open graded mixtures.

Hydraulic extensions on the paver will not be allowed for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving widths vary. Hydraulic extensions may be used on approaches, tapers, and added lanes less than 250 ft in length.

HMA shoulders which are 8 ft or more in width shall be placed with automatic paving equipment.

260 HMA mixtures in hauling equipment shall be protected by tarps from adverse weather conditions or foreign materials. Adverse weather conditions include, but will not be limited to, precipitation or temperatures below 45°F.

The speed of the paver shall not exceed 50 ft per minute when spreading mixtures.

270 Automatic slope and grade controls shall be required except when placing mixtures on roadway approaches which are less than 200 ft in length or on miscellaneous work. The use of automatic controls on other courses where use is impractical due to project conditions may be waived by the Engineer.

402.14

The finished thickness of each course shall be at least two times but not more than four times the maximum particle size as shown on the DMF or JMF. The finished thickness of wedge and level mixtures shall be at least 1 1/2 times but not more than six times the maximum particle size as shown on the DMF or JMF. Feathering may be less than the minimum thickness requirements.

280 Rumble strips shall be placed to ensure uniformity of depth, width, texture, and the required spacing between strips. A tack coat in accordance with 406 shall be applied on the pavement surface prior to placing the mixture. The tack coat may be applied with a paint brush or other approved methods.

A safety edge shall be constructed at locations where an intermediate mixture or a surface mixture is constructed adjacent to an aggregate or earth shoulder.

**402.14 Joints**

290 Longitudinal joints in the surface shall be at the lane lines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 6 in., and be located within 12 in. of the lane line.

Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

**402.15 Compaction**

300 The HMA mixture shall be compacted with equipment in accordance with 409.03(d) immediately after the mixture has been spread and finished. Rollers shall not cause undue displacement, cracking, or shoving.

A roller application is defined as one pass of the roller over the entire mat. Compaction operations shall be completed in accordance with one of the following options.

NUMBER OF ROLLER APPLICATIONS							
Rollers	Courses ≤ 440 lb/sq yd					Courses > 440 lb/sq yd	
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 1	Option 2
Three Wheel	2		4			4	
Pneumatic Tire	2	4				4	
Tandem	2	2	2			4	
Vibratory				6			8
Oscillatory					6	-	-

A reduced number of applications on a course may be approved if detrimental results are being observed.

310        Compaction equipment shall be operated with the drive roll or wheels nearest the paver and at speeds not to exceed 3 mph. However, vibratory rollers will be limited to 2.5 mph. Rolling shall be continued until applications are completed and all roller marks are eliminated.

Compaction operations shall begin at the low side and proceed to the high side of the mat. The heaviest roller wheel shall overlap its previous pass by a minimum of 6 in.

320        Longitudinal joints shall be compacted in accordance with the following:

- (a) For confined edges, the first pass adjacent to the confined edge, the compaction equipment shall be entirely on the hot mat 6 in. from the confined edge.
- (b) For unconfined edges, the compaction equipment shall extend 6 in. beyond the edge of the hot mat.

330        All displacement of the HMA mixture shall be corrected at once by the use of lutes or the addition of fresh mixture as required. The line and grade of the edges of the HMA mixture shall not be displaced during rolling.

The wheels shall be kept properly moistened with water or water with detergent to prevent adhesion of the materials to the wheels.

Areas inaccessible to rollers shall be compacted thoroughly with hand tampers or other mechanical devices in accordance with 409.03(d)7 to achieve the required compaction. A trench roller, in accordance with 409.03(d)6, may be used to obtain compaction in depressed areas.

340        The final two roller applications shall be completed at the highest temperature where the mixture does not exhibit any tenderness.

Vehicular traffic will not be allowed on a course until the mixture has cooled sufficiently to prevent distortions.

Rumble strips shall be compacted with vibratory compacting equipment in accordance with 409.03(d)7 unless otherwise stated.

#### **402.16 Low Temperature Compaction Requirements**

350        Compaction for mixtures placed below the temperatures listed in 402.12 shall be controlled by density determined from MSG of the plate samples and cores cut from the compacted pavement placed during a low temperature period. Samples shall be

402.17

obtained in accordance with ITM 580. Acceptance will be based on a plate sample and two cores. The Engineer will randomly select the locations in accordance with ITM 802. The transverse core location will be located so that the edge of the core will be no closer than 3 in. from a confined edge or 6 in. from a non-confined edge of the course being placed.

360 For compaction of HMA during low temperature periods with quantities less than 100 t per day, acceptance may be visual.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6 in. diameter pavement sample. Coring shall be completed prior to the random location being covered. The final HMA course shall be cored within one work day of placement. Damaged cores shall be discarded and replaced with a core from a location selected by adding 1 ft to the longitudinal location of the damaged core using the same transverse offset.

370 The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than two times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific section will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1 ft from the random location using the same transverse offset.

380 The density for the mixture shall be expressed as:

$$\text{Density} = 100 \times \text{BSG}/\text{MSG}$$

where:

BSG = average bulk specific gravity

MSG = maximum specific gravity

390 The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166 Method A or AASHTO T 275, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. Density shall not be less than 92.0%.

Within one work day of coring operations, the Contractor shall clean, dry, refill, and compact the core holes with suitable HMA of similar or smaller size particles.

#### **402.17 Shoulder Corrugations**

Shoulder corrugations shall be in accordance with 606.



**402.18 Pavement Smoothness**

400 Pavement smoothness will be in accordance with 401.18 except profilograph requirements will not apply.

**402.19 Method of Measurement**

HMA mixtures will be measured by the ton of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

HMA rumble strips will be measured by the linear foot of each transverse strip, complete in place.

410 Milled shoulder corrugations will be measured in accordance with 606.02.

**402.20 Basis of Payment**

The accepted quantities for this work will be paid for at the contract unit price per ton for HMA, of the type specified complete in place.

HMA rumble strips will be paid for at the contract unit price per linear foot, of each transverse strip complete in place.

420 Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
HMA Rumble Strips.....	LFT
HMA for Temporary Pavement, Type ____*	TON
HMA Wedge and Level, Type ____*	TON
* Mixture type	

430 Preparation of surfaces to be overlaid shall be included in the cost of other pay items in this section.

No payment will be made for additional anti-stripping additives.

The cost of removing and replacing soft yielding areas shall be included in the cost of other pay items in this section.

440 No payment will be made for coring operations and related traffic control expenditures required in 402.16.

Corrections for pavement smoothness including removal and replacement of pavement, shall be included in the cost of other pay items in this section.

**SECTION 403 – COLD MIX ASPHALT, CMA, PAVEMENT**

**403.01 Description**

This work shall consist of the construction of one or more courses of CMA base, intermediate, or surface for immediate use or stockpiled in accordance with 105.03.

**MATERIALS**

**403.02 Materials**

10 Materials shall be in accordance with the following:

	Asphalt Materials	
	For Immediate Use,	
	Asphalt Emulsion AE-150, AE-90 .....	902.01(b)
	For Stockpiling,	
	Asphalt Emulsion AE-150 .....	902.01(b)
	Course Aggregates.....	904
	Base, Class D or Higher	
	Intermediate, Class C or Higher	
	Surface, Class B or Higher	
20	Fine Aggregates.....	904

Acceptance of the mixture will be in accordance with the Frequency Manual on the basis of a type D certification in accordance with 916.

**CONSTRUCTION REQUIREMENTS**

**403.03 Weather Limitations**

30 CMA pavements shall not be placed on a wet surface, when the ambient temperature is below 40°F, or when other unsuitable conditions exist, unless approved by the Engineer.

**403.04 Equipment**

Mixing plant, hauling trucks, pavers, and rollers shall be in accordance with 409.

**403.05 Preparation of Mixtures**

The size of the aggregate and the grade of asphalt materials shall be as specified. The gradations and percent of asphalt shall be as follows.

COMPOSITION LIMITS FOR CMA MIXTURES						
Sieve Size	Total % of Aggregates Passing Sieves Based on Total Weight of Aggregates					
	Size 2	Size 5	Size 8	Size 9	Size 11	Size 5D
2.5 in. (63 mm)	100					
2 in. (50 mm)	95-100					
1.5 in. (37.5 mm)		100				100
1 in. (25 mm)	0-25	85-100	100			80-99
3/4 in. (19.0 mm)	0-10	60-90	75-100	100		68-90
1/2 in. (12.5 mm)	0-7	30-65	40-75	65-90	100	54-76
3/8 in. (9.5 mm)		15-50	20-55	30-65	75-100	45-67
No. 4 (4.75 mm)		0-20	0-20	0-20	10-35	30-50
No. 8 (2.36 mm)		0-15	0-15	0-15	0-15	20-45
No. 30 (600 μm)						7-28
No. 200 (75 μm)	0-5	0-5	0-5	0-6	0-6	0-6
Minimum % Crushed	95	95	95	95	95	95
% of Asphalt*	2.0-3.5	2.5-4.0	3.0-4.5	3.5-5.0	4.0-6.0	3.5-5.0

\* Percent of asphalt shall be calculated on the basis of the total weight of the mixture, exclusive of water or solvent. When slag is used, the asphalt content will be adjusted to compensate for the specific gravity and surface area.

40

The moisture condition of the aggregate shall be such that the aggregate is uniformly coated and satisfactorily retains the required amount of asphalt during the stockpiling, hauling, and spreading operations. Mixtures shall not be produced at temperatures exceeding 180°F.

#### 403.06 Preparation of Subgrade or Base

Mixtures for CMA base may be placed on an earth subgrade, on an existing pavement surface to be used as a base, or on a previously prepared base or subbase as specified. If such material is to be laid on a newly prepared subgrade, then all applicable requirements of 207 shall apply.

50

#### 403.07 Spreading Mixture

The CMA mixture shall be spread in accordance with 402.13.

A safety edge shall be constructed at locations where an intermediate mixture or a surface mixture is constructed adjacent to an aggregate or earth shoulder.

#### 403.08 Curing

All CMA mixtures shall be allowed to cure sufficiently to prevent undue distortions under the roller wheels.

60

When a CMA mixture is allowed to cure under traffic, the surface shall be maintained and all damaged areas shall be satisfactorily repaired.



following:

Asphalt Emulsion, RS-2, AE-90, AE-90S, or HFRS-2 ..... 902.01(b)

20

#### 404.04 Cover Aggregate

Aggregate shall be in accordance with the following requirements. When slag is used as an alternate to natural aggregate, adjustments will be made in accordance with 904.01, to compensate for differences in specific gravity.

Coarse Aggregates, Class B or Higher

Size No. 8, 9, 11, or 12 ..... 904

Fine Aggregate, Size No. 23 or 24 ..... 904

30

The types of seal coats shall be as follows:

Type (see Note 1)	Application	Cover Aggregate Size No. and Course	Rates of Application per sq yd	
			Aggregate, lb	Asphalt Material, Gal. at 60°F
1 or 1P (see Note 2)	Single	23, 24	12 - 15	0.12 - 0.16
2 or 2P	Single	12	14 - 17	0.29 - 0.33
3 or 3P	Single	11	16 - 20	0.36 - 0.40
4 or 4P	Single	9	28 - 32	0.63 - 0.68
5 or 5P	Double	Top: 12	16 - 19	0.33 - 0.37
		Bottom: 11	16 - 20	0.36 - 0.40
6 or 6P	Double	Top: 11	18 - 22	0.41 - 0.46
		Bottom: 9	28 - 32	0.63 - 0.68
7 or 7P	Double	Top: 11	18 - 22	0.41 - 0.46
		Bottom: 8	28 - 32	0.63 - 0.68

Note 1 – AE-90S shall be used for type P seal coats.  
 Note 2 – HFRS-2 shall not be used with type 1 seal coat.

## CONSTRUCTION REQUIREMENTS

#### 404.05 Weather Limitations

Asphalt material shall not be applied on a wet surface, or when other weather conditions would adversely affect the seal coat. Seal coat shall not be placed when the ambient or pavement temperature is below 60°F. Seal coat shall not be applied to travel lanes or auxiliary lanes before May 1 or after October 1, but may be applied to shoulders within the above temperature range.

40

#### 404.06 Equipment

A distributor, rotary power broom, pneumatic tire roller, and aggregate spreader in accordance with 409.03 shall be used.

**404.07 Preparation of Surface**

Surfaces to be sealed shall be patched as shown on the plans or as directed, brought to proper section and grade, and compacted.

- 50 The surface shall be cleaned of all loose material prior to seal coat application. Sealing operations may not commence until the surface is approved.

All castings, detector housings, and snowplowable raised pavement markers shall be covered prior to applying the asphalt material to prevent coating with seal coat. These coverings shall be removed prior to opening to unrestricted traffic.

**404.08 Applying Asphalt Material**

- 60 Asphalt material shall be applied in a uniform continuous spread over the section to be treated. The quantity of asphalt material to be applied per square yard shall be in accordance with the QCP. During application, minor adjustments to the application rate shall be made in accordance with the QCP.

The asphalt material shall not be spread over a greater area than that which can be covered with the cover aggregate that is in trucks at the site.

- 70 The spread of the asphalt material shall be no wider than the width covered by the cover aggregate from the spreading device. Operations shall not proceed such that asphalt material is allowed to chill, set up, dry, or otherwise impair retention of the cover coat.

**404.09 Application of Cover Aggregate**

Within 1 minute of the application of the asphalt material, cover aggregate shall be spread in quantities as required. Spreading shall be accomplished such that the tires of the trucks or aggregate spreader do not contact the uncovered and newly applied asphalt material.

**404.10 Rolling Operation**

- 80 The aggregate shall be seated with at least three roller applications. A roller application is defined as one pass of the roller over the width sealed. The first roller application shall be completed within 2 minutes of aggregate application, with the final application completed within 30 minutes after the cover aggregate is applied. The rollers shall not be operated at speeds that will displace the cover aggregate from the asphalt material.

**404.11 Sweeping Operation**

- 90 Excess cover aggregate shall be removed from the pavement surface by brooming no later than the morning after placement of the seal coat. The brooming shall not displace the imbedded aggregate. A second brooming operation shall be performed prior to opening to unrestricted traffic in accordance with 101.33.



405.03

following:

Asphalt Emulsion, AE-PMP..... 902.01(b)

**405.03 Cover Aggregate**

Aggregate shall be in accordance with the following:

	Coarse Aggregate, Class B or Higher,	
	Size No. 12 .....	904
20	Fine Aggregate, Size No. 23 or 24 .....	904

**CONSTRUCTION REQUIREMENTS**

**405.04 Weather Limitations**

Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 50°F, or when other unsuitable conditions exist, unless approved by the Engineer.

**405.05 Equipment**

30 A distributor and aggregate spreader in accordance with 409.03 shall be used.

**405.06 Preparation of Surface**

The existing surface to be treated shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities; uniformly compacted; and approved.

**405.07 Application of Asphalt Material**

40 AE-PMP shall be uniformly applied at the rate of 0.50 to 0.75 gal./sq yd placed in a single application. When placing material on a rubblized base, a carpet drag shall be utilized behind the distributor.

When traffic is to be maintained within the limits of the section, approximately one half of the width of the section shall be treated in one application. Complete coverage of the section shall be ensured. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

**405.08 Cover Aggregate**

50 If the asphalt material fails to penetrate and the primed surface must be used by traffic, cover aggregate shall be spread to provide a dry surface.

**405.09 Method of Measurement**

Asphalt for prime coat will be measured by the ton, or by the square yard. Cover aggregate will be measured by the ton.



**405.10 Basis of Payment**

The accepted quantities of prime coat will be paid for at the contract unit price per ton, or per square yard for asphalt for prime coat. The accepted quantities of cover aggregate will be paid for at the contract unit price per ton, complete in place.

60 Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
Asphalt for Prime Coat.....	TON
	SYS
Cover Aggregate, Prime Coat.....	TON

**SECTION 406 – TACK COAT**

**406.01 Description**

This work shall consist of preparing and treating an existing pavement or concrete surface with asphalt material in accordance with 105.03.

**MATERIALS**

**406.02 Materials**

10 The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-T, AE-PMT, SS-1h, AE-NT.....	902.01(b)
PG Asphalt Binder, PG 64-22 .....	902.01(a)

**CONSTRUCTION REQUIRMENTS**

**406.03 Equipment**

20 A distributor in accordance with 409.03(a) shall be used.

**406.04 Preparation of Surface**

The existing surface to be treated shall be free of foreign materials deemed detrimental by the Engineer.

**406.05 Application of Asphalt Material**

The asphalt material shall be uniformly applied at the rate of from 0.03 to 0.08 gal./sq yd, or as otherwise specified or directed.

30 Tack coat shall not be applied to a wet surface. The rate of application, temperature, and areas to be treated shall be approved prior to application. Excessive tack coat shall be corrected to obtain an even distribution.

406.06

**406.06 Method of Measurement**

Asphalt for tack coat will be measured by the ton or by the square yard.

**406.07 Basis of Payment**

The accepted quantities of tack coat will be paid for at the contract unit price per ton, or per square yard for asphalt for tack coat, complete in place.

40 Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
Asphalt for Tack Coat .....	TON SYS

**SECTION 407 – DUST PALLIATIVE**

**407.01 Description**

This work shall consist of preparing and treating an existing aggregate surface with asphalt material in accordance with 105.03.

**MATERIALS**

**407.02 Asphalt Material**

10 The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-PL .....	902.01(b)
-------------------------------	-----------

**CONSTRUCTION REQUIREMENTS**

**407.03 Weather Limitations**

20 Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 50°F, or when other unsuitable conditions exist, unless approved by the Engineer.

**407.04 Equipment**

A distributor in accordance with 409.03(a) shall be used.

**407.05 Preparation of Surface**

The surface to be treated shall be shaped to the required section and be free from all ruts, corrugations, or other irregularities.

**407.06 Application of Asphalt Material**

30 The asphalt material shall be uniformly applied at the rate of 0.25 to 1 gal./sq yd in a uniform continuous spread over the section to be treated or as directed.

When traffic is to be maintained within the limits of the section, approximately one half of the width of the section shall be treated in one application. Complete coverage of the section shall be ensured. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

**407.07 Method of Measurement**

Asphalt for dust palliative will be measured by the ton.

40

**407.08 Basis of Payment**

The accepted quantities of this work will be paid for at the contract unit price per ton for asphalt for dust palliative, complete in place.

Payment will be under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
Asphalt for Dust Palliative .....	TON

**SECTION 408 – SEALING CRACKS AND JOINTS**

**408.01 Description**

This work shall consist of sealing longitudinal and transverse cracks and joints in existing asphalt pavement in accordance with 105.03.

**MATERIALS**

**408.02 Materials**

10

Materials shall be in accordance with the following:

Asphalt Binder for Crack Sealing, PG 64-22* .....	902.01(a)
Asphalt Emulsion for	
Crack Sealing, AE-90, AE-90S, AE-150.....	902.01(b)
Fine Aggregates, No. 23 or 24.....	904
Joint Sealing Materials .....	906.02

\* Polypropylene fibers shall be used only in conjunction with warranted micro-surfacing.

**CONSTRUCTION REQUIREMENTS**

20

**408.03 Equipment**

A distributor in accordance with 409.03 shall be used when crack sealing and an indirect-heat double boiler kettle with mechanical agitator shall be used when routing and filling. Air compressors shall be capable of producing a minimum air pressure of 100 psi.

**408.04 Weather Limitations**

Sealing or filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F, or when other unsuitable conditions exist, unless

408.05

30 approved by the Engineer.

**408.05 Routing and Filling Cracks and Joints**

Cracks and joints shall be routed when specified, with a routing machine capable of cutting a uniform shape to form a reservoir not exceeding 3/4 in. wide with a minimum depth of 3/4 in. The operation shall be coordinated such that routed materials do not encroach on pavement lanes carrying traffic and all routed materials are disposed of in accordance with 104.07. Cracks and joints shall be filled with hot poured joint sealant to within 1/4 in. of the surface in accordance with the manufacturer’s recommendations.

40

**408.06 Sealing Cracks and Joints**

Cracks and joints shall be cleaned by blowing with compressed air or by other suitable means. Asphalt material shall be placed utilizing a “V” shaped wand tip, to allow the penetration of the materials into the cracks and joints. The cracks and joints shall be completely filled or overbanded not to exceed 5 in., or as required. All excess asphalt material shall be removed from the pavement. The sealed cracks and joints shall be covered with sufficient fine aggregate to prevent tracking of the asphalt materials. All excess cover material shall be removed from the pavement.

50

Application of asphalt materials shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

**408.07 Method of Measurement**

Sealing and filling of cracks and joints in asphalt pavements will be measured by the ton of material used. Routing of cracks and joints will not be measured.

Temporary traffic control measures will be measured in accordance with 801.17.

60

**408.08 Basis of Payment**

Sealing and filling of cracks and joints in asphalt pavements will be paid for by the ton of material used for the type specified.

Temporary traffic control measures will be paid for in accordance with 801.18.

Payment will be made under:

70

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
Cracks and Joints in Asphalt Pavement, Seal .....	TON
Cracks and Joints in Asphalt Pavement, Rout and Seal .....	TON

The cost of all materials, cover aggregate, cleaning, and all necessary incidentals shall be included in the cost of the pay items in this section.

## SECTION 409 – EQUIPMENT

### **409.01 Production, Transportation, and Laydown of Asphalt Mixtures**

For production of asphalt mixtures, the Contractor shall provide all equipment necessary for the production, transportation, and laydown operations.

### **409.02 Mixing Plant**

The mixing plant shall be capable of producing a uniform mixture.

10           **(a) Certified HMA Plant**

A certified HMA plant shall be in accordance with ITM 583.

**(b) CMA Mixing Plant**

The mixing plant shall be of sufficient capacity and coordination to adequately handle the proposed CMA construction. The mixing unit shall be a twin shaft pugmill or other approved mixer, including the drum type capable of producing a consistent uniform mixture. The outlet of the mixer shall be such that it prevents segregation of the material when discharged.

20           A certified HMA plant in accordance with 409.02(a) may be utilized as a CMA mixing plant.

### **409.03 HMA Laydown Operations**

**(a) Distributor**

The distributor shall be equipped, maintained, and operated to provide uniform heating and application rates as specified. The distributor shall have a volume measuring device and a thermometer to monitor the asphalt material.

30           Distributors shall also be equipped with a power unit for the pump and with a full circulation spray bar with vertical controls.

**(b) Hauling Equipment**

The mixtures shall be transported to the laydown operation in trucks that have tight, clean, and smooth beds.

40           Truck beds may be treated with approved anti-adhesive agents. The truck beds shall be raised after application of non-foaming anti-adhesive agents to drain liquids from the bed prior to HMA being loaded into the truck. The Department will maintain a list of approved Anti-Adhesive Materials.

Hauling equipment shall be equipped with a watertight cover to protect the mixture.

**(c) Laydown Equipment**

### 1. Paver

The paver shall be self-propelled, and equipped with a material receiving system, and equipped with heated and vibrating screeds. The paver may also include automatic slope and grade controls, extendable screeds and extendable augers.

Automatic control devices shall be separated from the paver screeds, paver tracks or wheels and be capable of adjusting both sides of the screeds automatically to maintain a constant angle of attack in relation to the grade leveler device or grade line.

A grade leveling system may be used to activate the control devices on each HMA course, including matching lays. The leveling system shall be attached to the paver and operated parallel to the paver's line of travel.

Extendable screeds shall be rigid, heated, and vibrating, and be capable of maintaining the cross slope, and line and grade of the pavement, to produce uniform placement of the materials.

Auger extensions shall be used when required to distribute the HMA uniformly in front of the screed.

When a dense graded intermediate or a surface mixture is placed adjacent to an aggregate or earth shoulder, the side of the paver adjacent to the aggregate or earth shoulder shall be equipped with a device capable of constructing a safety edge. The following devices are approved for this application:

- (a) Advent-Edge™, Advent-Edge Paving Equipment LLC
- (b) Safety Edge End Gate, Carlson Paving Products, Inc.
- (c) TransTech Shoulder Wedge Maker™, TransTech Systems, Inc.
- (d) SafeTSlope Edge Smoother™, Troxler Electronic Laboratories, Inc.

### 2. Widener

A device capable of receiving, transferring, spreading, and striking off materials to the proper grade and slope.

### 3. Other Mechanical Devices

Inaccessible or short sections of HMA may be placed with specialty equipment approved by the Engineer.

#### (d) Compaction Equipment

Compaction equipment shall be self-propelled, steel wheel or pneumatic tire types, in good condition, and capable of reversing direction without backlash. All roller wheels shall be equipped with scrapers to keep the wheels clean, have water spraying devices on the wheels, and steering devices capable of accurately guiding the roller.

### 1. Tandem Roller

A roller having two axles and a minimum weight of 10 t.

### 2. Three Wheel Roller

A roller having three wheels with a minimum bearing of 300 lb/in. on the rear wheels. The crown of the wheels shall not exceed 2.5 in. in 18 ft.

- 100 A tandem roller which has a drive wheel bearing of no less than 300 lb/in. may be used in lieu of the three wheel roller.

### 3. Pneumatic Tire Roller

A pneumatic tire roller shall have a minimum rolling width of 5.5 ft. The roller shall be equipped with compaction tires, minimum size 7:50 by 15, exerting a uniform, average contact pressure from 50 to 90 psi uniformly over the pavement by adjusting ballast and tire inflation pressures. The wheels on at least one axle shall be fully oscillating vertically, and mounted as to prevent scuffing of the pavements during rolling or turning operations. Charts or tabulations showing the contact areas and pressures for the full range of tire inflation pressures and for the full range of tire loadings for each compactor shall be furnished to the Engineer.

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### 4. Vibratory Roller

A vibratory roller is a roller that has both drums equipped for vertical impact forces, a variable amplitude system, a speed control device, and have a minimum vibration frequency of 2,000 vibrations per minute. A reed tachometer shall be provided for verifying the frequency of vibrations.

### 5. Oscillatory Roller

An oscillatory roller is a roller that has both drums equipped for horizontal and vertical shear forces or one drum equipped for horizontal and vertical shear force and the other drum equipped for a vertical impact force.

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### 6. Trench Roller

A trench roller shall have a compaction wheel bearing of no less than 300 lb/in.

### 7. Specialty Roller/Compactor

Inaccessible or short sections of HMA may be compacted with specialty equipment approved by the Engineer.

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#### (e) Miscellaneous Equipment

#### 1. Aggregate Spreader

A spreader shall be a self-propelled, pneumatic tired, motorized unit with a front loading hopper and a transportation system for distributing the aggregates uniformly across the pavement.

#### 2. Rotary Power Broom

A motorized, pneumatic tired unit with rotary bristle broom head.

**(f) Smoothness Equipment**

**1. Profilograph**

The profilograph shall be in accordance with ITM 912.

**2. Straightedge – 16 ft**

A 16 ft straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft apart. The straightedge has a mounted push bar to facilitate propelling the device along or across the pavement. Tolerance points are located at the 1/4, 1/2, and 3/4 points and may be composed of threaded bolts capable of being adjusted to the tolerance required.

**3. Straightedge – 10 ft**

A 10 ft straightedge is the same as a 16 ft straightedge except that the wheels are mounted 10 ft apart. A handheld rigid beam may be substituted.

**SECTION 410 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HMA SURFACE – SMA PAVEMENT**

**410.01 Description**

This work shall consist of one course of QC/QA HMA Surface – SMA mixture constructed on prepared foundations in accordance with 105.03.

**410.02 Quality Control**

The SMA mixture shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Hot Mix Asphalt Producer Program. The QCP shall be modified to include the requirements for the SMA mixtures. The SMA shall be transported and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing SMA paving operations.

When a safety edge is required for a project, the QCP shall identify the device or devices in accordance with 409.03(c) to be used for constructing the safety edge.

**MATERIAL**

**410.03 Materials**

Materials shall be in accordance with the following:

Asphalt Materials	
PG Binder, PG 76-22, PG 70-22 .....	902.01(a)
Coarse Aggregates, Class AS .....	904
Fibers .....	AASHTO M 325
Fine Aggregates (sand, mineral filler) .....	904



#### 410.04 Design Mix Formula

A design mix formula, DMF, shall be prepared in accordance with 410.05 and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture. The DMF shall state the calibration factor, test temperature and absorption factors to be used for the determination of binder content using the ignition oven in accordance with ITM 586, the binder content by extraction in accordance with ITM 571, and a Mixture Adjustment Factor, MAF. The DMF shall state the source, type dosage rate of any stabilizing additives. Approval of the DMF will be based on the ESAL and mixture designation. A mixture number will be assigned by the Engineer. No mixture will be accepted until the DMF has been approved.

The ESAL category identified in the pay item correlates to the following ESAL ranges:

ESAL CATEGORY	ESAL
1	< 300,000
2	300,000 to < 3,000,000
3	3,000,000 to < 10,000,000
4	10,000,000 to < 30,000,000
5	≥ 30,000,000

The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 58-28, PG 64-22, PG 64-28 or PG 70-22 binders are used or 325°F whenever PG 70-28 or PG 76-22 binders are used. SMA may be produced using a water-injection foaming device. The DMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture.

#### 410.05 SMA Mix Design

The DMF shall be determined for each mixture from a SMA mix design by a design laboratory selected from the Department's list of approved Mix Design Laboratories. A SMA mixture shall be designed in accordance with AASHTO M 325 and R 46.

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation table.

SMA GRADATION CONTROL LIMITS (Percent Passing By Volume)				
	Mixture Designation			
	9.5 mm		12.5 mm	
Sieve Size	Lower	Upper	Lower	Upper
25.0 mm				
19.0 mm			100.0	100.0
12.5 mm	100.0	100.0	90.0	99.0
9.5 mm	70.0	95.0	50.0	85.0
4.75 mm	30.0	50.0	20.0	40.0
2.36 mm	20.0	30.0	16.0	28.0
1.18 mm	---	21.0	---	---
600 $\mu$ m	---	18.0	---	---
300 $\mu$ m	---	15.0	---	---
75 $\mu$ m	8.0	12.0	8.0	11.0

The optimum binder and aggregate gradation content shall produce 4.0% air voids. The maximum specific gravity shall be mass determined in water in accordance with AASHTO T 209. The percent draindown for SMA surface mixture shall not exceed 0.30% in accordance with AASHTO T 305.

- 70 The MAF equals the Gmm from the mixture design divided by the following: 2.465 for 9.5 mm mixtures and 2.500 for 12.5 mm mixtures. If the MAF calculation results in a value where  $0.980 \leq \text{MAF} \leq 1.020$ , then the MAF shall be considered to be 1.000. If the MAF is greater than 1.020, the calculated MAF value shall have 0.020 subtracted from the value. If the MAF is less than 0.980, the calculated MAF value shall have 0.020 added to the value. The MAF does not apply to OG mixtures.

- 80 The mixture shall be tested for moisture susceptibility in accordance with AASHTO T 283 except that the loose mixture curing shall be replaced by mixture conditioning for 2 h in accordance with AASHTO R 30. The minimum tensile strength ratio, TSR, shall be 70%. The 6 in. mixture specimens shall be compacted to  $6.0 \pm 1.0\%$  air voids in accordance with AASHTO T 312. Specimens shall be prepared using freeze-thaw preconditioning. If anti-stripping additives are added to the mixture to be in accordance with the minimum TSR requirements, the dosage rate shall be submitted with the DMF.

The fine aggregate portion of the aggregate blend shall be non-plastic as determined in accordance with AASHTO T 90.

- 90 A change in the source or types of aggregates, change in source or type of stabilizing additives, or a change in the source of the specified binder shall require a new DMF. A new DMF shall be submitted to the District Testing Engineer for approval one week prior to use.

The specific gravity of SF and the Gsb of the aggregate blend containing SF may be adjusted once per contract upon notification by the SF source and approval by the District Testing Engineer. A new DMF is not required for this adjustment.

The mixture design compaction temperature for the specimens shall be  $300 \pm 9^\circ\text{F}$ .

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VOIDS IN MINERAL AGGREGATE, VMA, CRITERIA	
Mixture Designation	Minimum VMA, %
12.5 mm	17.0
9.5 mm	17.0

#### 410.06 Recycled Materials

Recycled materials may consist of reclaimed asphalt pavement, RAP, or reclaimed asphalt shingles, RAS or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. RAS shall be 100% passing the 1/2 in. (12.5 mm) sieve. RAP shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

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Recycled materials may be used as a substitute for a portion of the new materials required to produce SMA mixtures. The amount of total binder replaced by binder in the recycled material shall be computed as follows:

$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E} \times 100\%$$

where:

A = RAP, % Binder Content

B = RAP, % in Mixture

C = RAS, % Binder Content

D = RAS, % in Mixture

E = Total, % Binder Content in Mixture

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RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. Post-consumer asphalt shingles shall be in accordance with AASHTO MP 15 and prepared by a processing company with an IDEM Legitimate Use Approval letter. A copy of this letter shall be submitted to the Engineer. Deleterious material present in post-consumer asphalt shingles shall be limited to the percentages stated in AASHTO MP 15. Pre-consumer and post-consumer asphalt shingles shall not be blended for use in SMA mixtures and shall be stockpiled separately from other materials.

130

The recycled material percentages shall be as specified on the DMF. SMA mixtures utilizing recycled materials shall be limited to the binder replacement

410.07

percentages in the following table:

SMA mixtures utilizing RAP or RAS or a blend of RAP and RAS MAXIMUM BINDER REPLACEMENT, %		
SMA Surface		
Mixture Category	12.5 mm	9.5 mm
1	40.0*	40.0*
2	40.0*	40.0*
3	25.0	25.0
4	25.0	25.0
5	25.0	25.0

\* RAS materials shall not contribute more than 25% by weight of the total binder content for any HMA mixture.

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The combined aggregate properties shall be in accordance with 904. The combined aggregate bulk specific gravity shall be determined in accordance with ITM 584 and the combined aggregate gradation shall be in accordance with 410.05 for the SMA mixture specified.

SMA mixtures with a binder replacement less than or equal to 25.0% by weight of the total binder content by utilizing RAP or RAS or a blend of RAP and RAS materials shall use the specified binder grade.

150

SMA mixtures with a binder replacement greater than 25.0% and less than or equal to 40.0% by weight of the total binder content by utilizing RAP or a blend of RAP and RAS shall use a binder grade with upper and lower temperature classifications reduced by 6°C from the specified binder grade. RAS materials shall not contribute more than 25.0% by weight of the total binder content for any SMA mixture.

**410.07 Lots and Sublots**

160 Lots will be defined as 2,400 t of SMA surface mixture. Lots will be further subdivided into sublots not to exceed 600 t of SMA surface mixture. Partial sublots of 100 t or less will be added to the previous subplot. Partial sublots greater than 100 t constitute a full subplot.

**410.08 Job Mix Formula**

A job mix formula, JMF, shall be developed by a certified HMA producer in accordance with ITM 583. A JMF used for SMA mixture the current or previous calendar year will be allowed. The mixture compaction temperature shall be 300 ± 9°F. The JMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture. The JMF for each mixture shall be submitted to the Engineer.

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#### 410.09 Acceptance of Mixtures

Acceptance of mixtures for binder content and gradation for each lot will be based on tests performed by the Engineer. The Engineer will randomly select the location within each subplot for sampling in accordance with ITM 802. An acceptance sample will consist of one plate sample at the random location. A backup sample will consist of one plate sample located 2 ft towards the center of the mat from the acceptance sample.

180 Samples from each location shall be obtained from each subplot from the pavement in accordance with ITM 580. The Engineer will take immediate possession of the samples.

A maximum specific gravity sample and a binder content and gradation sample will be obtained from the plate sample in accordance with ITM 587. The binder content will be determined in accordance with ITM 586 or ITM 571 as directed by the Engineer and the gradation will be determined in accordance with AASHTO T 30. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. The test results of the sublots will be averaged and shall meet the requirements for tolerances from the JMF for each sieve and binder content.

190

The Engineer's acceptance test results for each subplot will be available after the subplot and testing are complete. During the adjustment period the test results will be made available after testing is complete.

ACCEPTANCE TOLERANCE FOR MIXTURES (Percent Mass)							
Mixture	Number of Tests	Sieve Size					
Surface		*12.5 mm	*9.5 mm	*4.75 mm	2.36 mm	600 μm	75 μm
	1				8.0	4.0	2.5
	2				5.7	2.8	2.1
	3				4.6	2.3	1.8
	4				4.0	2.0	1.5
* The acceptance tolerance for this sieve shall be the applicable composition limits specified in 410.05.							

ACCEPTANCE TOLERANCE FOR BINDER				
Binder Content	Number of Tests			
	1	2	3	4
% Binder	0.7	0.5	0.4	0.3

Acceptance of mixtures for range will be determined using the results of subplot tests performed by the Engineer from each lot. If the range is not in accordance with the requirements, adjustment points will be assessed in accordance with 410.19(a).

200

ACCEPTANCE TOLERANCE FOR RANGE ( $\pm$ Percent Mass)	
Sieve Size and Binder Content	Percentage Points
	Surface
2.36 mm	12.0
600 $\mu$ m	6.0
75 $\mu$ m	2.0
% Binder	1.0

Acceptance tolerances for binder content and gradation will be as set out above for the number of tests performed. The acceptance tolerance for range will be as set out above for lots of more than one subplot. The range of binder shall be the difference between the highest subplot binder content and the lowest subplot binder content in one lot. The range of gradation shall be the difference between the highest subplot percent passing and the lowest subplot percent passing each required sieve in one lot.

210

Single test values and averages will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

Lot adjustment points will be assessed in accordance with 410.19(a) when the average or range for binder content or gradation are not met.

The Contractor may request an appeal of the Engineer's test results in accordance with 410.20.

220

A binder draindown test in accordance with AASHTO T 305 shall be completed once per lot in accordance with 410.07 and shall not exceed 0.30%.

Stabilizing additives incorporated into the mixture will be accepted on the basis of a type A certification for the specified material properties for each shipment of fibers. Stabilizing additives from different manufacturers and different types of additives shall not be intermixed.

In the event than an acceptance sample is not available to represent subplot, all test results of the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

230

## CONSTRUCTION REQUIREMENTS

### 410.10 General

Equipment for SMA operations shall be in accordance with 409. The Contractor shall submit to the Engineer prior to use a written Certificate of Compliance that the proposed paving equipment has been modified in accordance with 401.10 or is new and includes the modifications.

240 Fuel oil, kerosene, or solvents shall not be transported in open containers on equipment. Cleaning of equipment and small tools shall not be accomplished on the pavement or shoulder areas.

Segregation, flushing or bleeding of SMA mixtures will not be allowed. Corrective action shall be taken to prevent continuation of these conditions. Segregated, flushed or bleeding of SMA mixtures shall be removed if directed. All areas showing an excess or deficiency of binder shall be removed and replaced.

250 All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

#### **410.11 Preparation of Surfaces to be Overlaid**

Milling of an existing pavement surface shall be in accordance with 306.05. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

260 Milled asphalt surfaces and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

#### **410.12 Process Control**

The Engineer and Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

#### **410.13 Weather Limitations**

SMA courses shall be placed when the ambient temperature and the temperature of the surface on which it is to be placed is 45°F or above.

#### **270 410.14 Spreading and Finishing**

The mixture shall be placed upon an approved surface by means of a paver or other mechanical devices in accordance with 409.03. Mixtures in areas inaccessible to mechanical devices may be placed by other methods.

Prior to paving, both the planned quantity and lay rate shall be adjusted by multiplying by the MAF. When mixture is produced from more than one DMF or JMF for a given pay item, the MAF will be applied to the applicable portion of the mixture for each.

280 Planned SMA courses greater than 220 lb/sq yd placed under traffic, shall be brought up even with each adjacent lane at the end of each work day. Planned SMA courses less than or equal to 220 lb/sq yd shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane.

410.15

Hydraulic extensions on the paver will not be allowed for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving widths vary. Hydraulic extensions may be used in tapers and added lanes less than 250 ft in length.

Automatic slope and grade controls will be required and shall be outlined in the QCP.

SMA mainline and SMA shoulders which are 8 ft or more in width shall be placed with automatic paving equipment.

The rollers shall be operated to avoid shoving of the SMA and at speeds not to exceed 3 mph. Rollers shall be in accordance with 409.03(d)1, 2, or 7. Vibratory rollers meeting the requirements of 409.03(d)4 may be used but shall not be operated in vibratory mode, except the vibratory mode may be used on the first pass to the paver.

The finished thickness of any course shall be at least two times but not more than four times the maximum particle size as shown on the DMF.

A safety edge shall be constructed at locations where the surface mixture is constructed adjacent to an aggregate or earth shoulder.

310 **410.15 Joints**

Longitudinal joints in the surface shall be at the lane lines of the pavement.

Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course. For areas inaccessible to rollers, other mechanical devices shall be used to achieve the required density.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

320 **410.16 Density**

Acceptance will be based on lots and sublots in accordance with 410.07.

The Engineer's acceptance test results for each subplot will be available after the subplot and testing are complete.

Sublot and lot density values will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

Density acceptance for all SMA mixtures shall be based on cores cut from the compacted pavement and analysis of pavement samples obtained in accordance with ITM 580. Acceptance will be based on lots and sublots in accordance with 410.07.



The Engineer will randomly select two locations in accordance with ITM 802, within each subplot for coring. The transverse core location will be located so that the edge of the core will be no closer than 3 in. from a confined edge or 6 in. from a non-confined edge of the course being placed. The maximum specific gravity will be determined from the sample obtained in 410.09.

340 The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6 in. diameter pavement sample. Surface courses shall be cored within one work day of placement. Damaged core shall be discarded and replaced with a core from a location selected by adding 1 ft to the longitudinal location of the damaged core using the same transverse offset.

The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than two times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

350 The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific subplot or sublots will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1 ft from the random location using the same transverse offset.

360 The density of the mixture will be expressed as the percentage of maximum specific gravity, %MSG, obtained by dividing the average bulk specific gravity by the maximum specific gravity for the subplot, times 100. Samples for the bulk specific gravity and maximum specific gravity will be dried in accordance with ITM 572. The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166, Method A or AASHTO T 275, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. The target value for density of SMA mixtures of each subplot shall be 93.0%.

The densities of the sublots will be averaged to determine the density of the lot.

Within one work day of coring operations the Contractor shall clean, dry, and refill the core holes with SMA of similar or smaller size particles or other approved materials. The Contractor's plan for refilling core holes shall be outlined in the QCP.

#### 370 **410.17 Shoulder Corrugations**

Shoulder corrugations shall be in accordance with 606.

#### **410.18 Pavement Smoothness**

The pavement smoothness will be evaluated and determined in accordance with 401.18.

#### **410.19 Adjusted Points**

When test results for mixture properties or density exceed the allowable

410.19

380 tolerances, adjustment points will be assessed. The adjustment points will be used to calculate a quality assurance adjustment quantity, q, for the lot. Quality assurance adjustment points for smoothness will be in accordance with 401.19(c).

The adjustment for mixture properties and density are calculated as follows:

$$q = 1.00 \times (L \times U \times P/100)/MAF$$

where:

- q = quality assurance adjustment quantity
- L = lot quantity
- 390 U = unit price for the material, \$/ton
- P = total adjustment points

The total quality assurance adjustments is to be calculated as follows:

$$Q = Q_s + \sum (q_m + q_d)$$

where:

- Q = total quality assurance adjustment quantity
- 400  $Q_s$  = quality assurance adjustment for smoothness as calculated in 401.19(c)
- $q_m$  = lot adjustments for mixtures
- $q_d$  = lot adjustments for density

If the total adjustment points for a lot are greater than 15, the pavement will be evaluated by the Office of Materials Management. If the Contractor is not required to remove the mixture, quality assurance adjustments of the lot will be assessed or other corrective actions as determined by the Office of Materials Management.

**(a) Mixture**

410 When test results for the mixture furnished exceeded the allowable tolerances, adjustment points will be assessed as follows:

ADJUSTMENT POINTS FOR GRADATION						
Adjustment Points	Sieve Size					
	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 μm	75 μm
For each 0.1% up to 1.0% Out of Tolerance	0.1	0.1	0.1	0.1	0.2	0.3
For each 0.1% > 1.0% Out of Tolerance	0.1	0.1	0.1	0.2	0.3	0.6

Gradation adjustment points for the lot shall be the sum of points calculated for up to 1% out of tolerance and the points calculated for greater than 1% out of tolerance in accordance with 410.09.

Binder content adjustment points for the lot shall be two points for each 0.1% above the tolerance or four points for each 0.1% below the tolerance in accordance with 410.09.

420

When test results for the mixture furnished exceed the allowable range in accordance with 410.09, adjustment points will be assessed as follows:

ADJUSTMENT POINTS FOR RANGE	
Sieve Size and Binder Content	Adjustment Points (For each 0.1% Out of Range)
2.36 mm	0.1
600 $\mu$ m	0.1
75 $\mu$ m	0.1
% Binder	1.0

For mixtures produced during a certified HMA plant's adjustment period, adjustment points will not be assessed if the mixture produced is in accordance with the following:

430

1. The gradation complies with 410.05 with the allowable tolerance limits shown in 410.09.
2. The range for the binder content and gradation do not exceed the limits shown in 410.09.
3. The binder content is within the tolerance requirements of 410.09.

If the mixture is not in accordance with these requirements, adjustment points will be assessed in accordance with 410.09 for variations exceeding the requirements shown above.

440

### (b) Density

When the density of the lot is outside the allowable tolerances, adjustment points will be assessed as follows:

DENSITY	
Percentages are based on %MSG	Pay Adjustments – Percent
> 97.0	Submitted to the Office of Materials Management*
93.0 – 97.0	0.00
92.0 – 92.9	0.20 points for each 0.10% below 93.0
91.0 – 91.9	2.00 + 0.40 points for each 0.10% below 92.0
89.0 – 90.9	6.00 + 1.00 points for each 0.10% below 91.0
$\leq$ 89.0	Submitted to the Office of Materials Management*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.	

### 410.20 Appeals

If the QC test results do not agree with the acceptance test results, a request, along with the QC test results, may be made in writing for additional testing. Additional testing may be requested for one or more of the following tests: binder content, gradation, or MSG of the mixture samples and bulk specific gravity of the density cores. The appeal request shall be submitted within seven calendar days of receipt of the Department's written results for that subplot. The request for the appeal for MSG, BSG of the density cores or binder content and gradation shall be submitted within seven calendar days of receipt of the Department's written results for that subplot. The subplot and specific tests shall be specified at the time of the appeal request. Only one appeal request per subplot is allowed. Upon approval of the appeal, the Engineer will perform additional testing.

The appeal results will replace all previous test results for acceptance of mixture in accordance with 410.09 and density in accordance with 410.16. The results will be furnished to the Contractor. The backup mixture samples or density cores will be tested in accordance with the following:

#### (a) MSG

The backup MSG will be dried in accordance with ITM 572 and mass determined in water in accordance with AASHTO T 209.

#### (b) Binder Content and Gradation

The backup binder content and gradation sample will be prepared and tested in accordance with the test methods that were used for acceptance.

#### (c) BSG of the Density Core

Cores shall be taken within seven calendar days unless otherwise directed. Additional core locations will be determined by adding 1 ft longitudinally of the cores tested using the same transverse offset. The cores will be dried in accordance with ITM 572 and tested in accordance with AASHTO T 166, Method A or AASHTO T 275, if required. The Contractor shall clean, dry, and refill the core holes with SMA or HMA surface materials within one work day of the coring operations.

### 410.21 Method of Measurement

SMA mixtures will be measured by the ton of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

### 410.22 Basis of Payment

The accepted quantities for this work will be paid for at the contract unit price per ton for QC/QA-HMA, of the type specified, – SMA, complete in place.

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made in accordance with 401.22.

Adjustments to the contract payment with respect to mixture, density, and smoothness for mixture produced will be included in a quality assurance adjustment pay item. The unit price for this pay item will be \$1.00 and the quantity will be in units of dollars. The quantity is the total calculated in accordance with 410.19. A change order developed in accordance with 109.05 will be prepared to reflect contract adjustments.

500 Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
QC/QA-HMA, _____, _____, _____, _____ mm, SMA.....	TON
(ESAL <sup>(1)</sup> ) (PG <sup>(2)</sup> ) (Course <sup>(3)</sup> ) (Mix <sup>(4)</sup> )	
Quality Assurance Adjustment.....	DOL
(1) ESAL Category as defined in 410.04	
(2) Number represents the high temperature binder grade. Low temperature grades are - 22	
(3) Surface	
(4) Mixture Designation	

510

Preparation of surfaces to be overlaid shall be included in the cost of other pay items within this section.

Coring and refilling of the pavement holes shall be included in the cost of other pay items within this section.

520 No payment will be made for additional anti-stripping additives, appeal coring or related traffic control expenditures for coring operations.

Corrections for pavement smoothness shall be included in the cost of other pay items within this section.

The price for profilograph, HMA will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

**SECTION 411 – WARRANTED MICRO-SURFACING**

**411.01 Description**

This work shall consist of furnishing materials and the placement of warranted micro-surfacing in accordance with 105.03. Multiple course micro-surfacing shall consist of a surface course over a rut fill or leveling course. Single course micro-surfacing shall consist of a surface course.

10 The Contractor shall be responsible for the warranted micro-surfacing in accordance with 411.09.

**411.02 Materials**

Materials shall be in accordance with the following:

Asphalt Emulsion .....	As Defined*
Coarse Aggregates – Class B or Higher ** .....	904
Fine Aggregates*** .....	904
Portland Cement, Type I .....	901.01(b)
Water .....	913.01

20

\* Polymer Modified Asphalt Emulsion shall be a quick-set, CSS-1h emulsion in accordance with AASHTO M 208 except the cement-mixing test is waived. The polymer material shall be milled or blended into the asphalt or blended into the emulsifier solution prior to the emulsification process. The minimum polymer solids content will be 3.0% based on the residual of the emulsion. Mix set additives shall be added as required to provide control of the quick-set properties. Additional requirements shall be in accordance with the following:

Characteristics	Test Method	Requirement
Residue by Distillation, %	AASHTO T 59	62+
Softening Point, °F (°C)	AASHTO T 53	140+ (60+)
Viscosity @ 140°F (60°C)	AASHTO T 202	8000+
Elastic Recovery @ 77°F (25°C), %	AASHTO T 301	60

30

\*\* The coarse aggregate angularity shall be a minimum of 95% in accordance with ASTM D 5821. The coarse aggregate for rut fill shall be limestone, dolomite, crushed gravel, sandstone, ACBF, or SF. The surface application aggregate type shall be based on the ESAL category in the Surface Aggregate Table below.

\*\*\* The fine aggregate for micro-surface shall be limestone, dolomite, crushed gravel, sandstone, ACBF, or SF. The fine aggregate angularity shall be a minimum of 45 in accordance with AASHTO T 304 Method A. The clay content of the blended aggregate material from the fine and coarse aggregates shall meet a minimum sand equivalency of 65 in accordance with AASHTO T 176. The surface leveling application aggregate type shall be based on the ESAL category as follows:

40

SURFACE AGGREGATE TABLE			
Coarse or Fine Aggregate Type	Traffic ESALs		
	< 3,000,000	< 10,000,000	≥ 10,000,000
Air-Cooled Blast Furnace Slag	Yes	Yes	Yes
Steel Furnace Slag	Yes	Yes	Yes
Sandstone	Yes	Yes	Yes
Crushed Dolomite	Yes	Yes	Note 1
Polish Resistant Aggregates	Yes	Yes	Note 1
Crushed Stone	No	No	No
Gravel	No	No	No
Note 1: Polish resistant aggregate or crushed dolomite may be used when blended with ACBF or sandstone but cannot exceed 50% of the coarse aggregate by weight, or cannot exceed 40% of the coarse aggregate by weight when blended with SF.			

**411.03 Design Mix Formula**

The Contractor shall submit a design mix formula, DMF, for the specific materials to be used on the project to the District Testing Engineer one week prior to use. The DMF shall state the following, where the percentages shown are based on the dry weight of the aggregate:

- (a) source of each individual material  
 (b) the aggregation gradation shall be in accordance with the following:

50

Sieve Size	Surface/Leveling, %	Rut Fill, % *
3/8 in. (9.5 mm)	100	100
No. 4 (4.75 mm)	85-100	70-90
No. 8 (2.36 mm)	50-80	45-70
No. 16 (1.18 mm)	40-65	28-50
No. 30 (600 µm)	25-45	19-34
No. 50 (300 µm)	13-25	12-25
No. 100 (150 µm)	7-18	7-18
No. 200 (75 µm)	5-15	5-15
* If rut fill course is used as a surface application, the aggregates shall be in accordance with the Surface Aggregate Table above.		

- (c) percentage of aggregate  
 (d) percentage of mineral filler, minimum and maximum  
 (e) percentage of water, minimum and maximum  
 (f) percentage of mix set additives, if required  
 (g) percentage of polymer modified CSS-1h emulsified asphalt  
 (h) state the quantitative effects of moisture content on the unit weight of the aggregate  
 (i) results for the tests in the following:

60

Characteristic	Test Method ISSA *	Requirement
Wet Cohesion 30 minutes, min. (set time) 60 minutes, min. (traffic)	TB-139**	12 kg-cm 20 kg-cm
Wet Stripping, min.	TB-114	90%
Wet Track Abrasion Loss 60 minutes soak, max.	TB-100	536 g/sq m
Saturated Abrasion Compatibility, max	TB-144	3g loss
Mix Time @ 77°F (25°C)	TB-113**	controllable to 120 s
Mix Time @ 104°F (40°C)	TB-113**	controllable to 35 s
* International Slurry Surfacing Association ** The TB-139 (set time) and TB-113 (mix time) tests shall be checked at the highest temperature expected during construction. For the TB-113 test at 104°F (40°C), all ingredients and containers shall be preheated.		

**411.04 Equipment**

The Contractor shall use self-contained, self-propelled, continuous loading units designed for micro-surfacing.

Truck-mounted batch type machines will be allowed on projects with quantities less than or equal to 50,000 sq yds. The Contractor shall provide a minimum of two truck-mounted units at all times.

70 **411.05 Pre-Paving Coordination**

A pre-paving meeting will be held on-site prior to beginning work. The Contractor shall furnish as a minimum:

- (a) the Contractor's detailed work schedule
- (b) traffic control plan
- (c) calibration of equipment
- (d) design mix formula/job mix formula
- (e) inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
- (f) Quality Control Plan in accordance with ITM 803.

80

**CONSTRUCTION REQUIREMENTS****411.06 Preparation of Surfaces**

The Contractor shall be responsible for all surface preparation necessary to meet the performance requirements for warranted micro-surfacing. All castings and detector housings shall be protected prior to the application of material in accordance with 404.07, except that raised pavement markers shall be removed.

90 **411.07 Opening to Traffic**

The micro-surface shall be capable of being opened to traffic within 1 h after application. If the micro-surface is not stable under traffic loading within 1 h of placement, the Contractor shall immediately cease operations. Prior to resuming operations, the Contractor shall notify the Engineer of the cause and the corrective action to be taken.

The microsurface shall be cured a minimum of five days prior to applying permanent pavement markings in accordance with 808.

100 **411.08 Finished Pavement Properties**

All finished surface irregularities in excess of 1/8 in. measured with a 10 ft straightedge shall be corrected.

The longitudinal construction joints and lane edges shall coincide with the proposed painted lane lines. Longitudinal joints shall be constructed with less than a 3 in. overlap on adjacent passes and no more than 1/4 in. overlap thickness measured



110 with a 10 ft straightedge in accordance with 409.03(f). If applicable, overlapping passes shall be made to prevent ponding of water. Construct transverse joints with no more than a 1/8 in. difference in elevation across the joint as measured with a 10 ft straightedge. The lane edge shall have no more than 2 in. of horizontal variance in 100 ft.

#### **411.09 Warranty**

A warranty bond is to insure completion of required warranty work, including payments for all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract used to remediate any warranted distresses.

120 The Contractor shall furnish to the Engineer a warranty bond at the preconstruction conference or prior to beginning any work on the contract. The warranty bond shall be equal to 100% of the contract total for the warranted micro-surfacing pay items, and shall be properly executed by a surety satisfactory to the Department, and shall be payable to the State of Indiana. The warranty bond shall be in effect for three years from the date of substantial completion.

Upon the final acceptance of the project, the contractual obligations of the Contractor are satisfied as long as the micro-surfacing continues to meet or exceed the warranted values as defined herein.

130 All warranty work shall be accomplished in accordance with 411.11. At the end of the warranty period, the Contractor will be released from further warranty work or responsibility, provided all previous warranty work has been satisfactorily completed and approved by the Department.

#### **411.10 Conflict Resolution Team**

The scope of work for the conflict resolution team includes all issues concerning the warranted pavement relative to the quality control plan, material selection, warranted pavement evaluations, distress indicators, remedial action, and remediation plans.

140 The team will consist of two Contractor representatives, two Department representatives, and an additional person mutually agreed upon by both the Department and the Contractor. All costs for the additional person will be equally shared by the Department and the Contractor.

150 The team members will be identified in writing when needed and will be knowledgeable in the terms and conditions of this warranty and the methods used in the measurement and calculation of pavement distress. The team will render a final recommendation to the Chief Engineer by a majority vote. Each member has an equal vote.

**411.11 Warranty Work**

Elective work is performed by the Contractor at its discretion to meet the performance requirements of warranted micro-surfacing prior to direction from the Department for the Contractor to perform remedial work.

Remedial work is performed as a result of pavement distress surveys performed by the Department.

160 During the warranty period, elective work and remedial work shall be performed at no cost to the Department. Elective work shall be at the Contractor's option. The scope of all elective work or remedial work to be performed as well as materials to be used shall be proposed by the Contractor and shall be subject to approval by the Department. Prior to proceeding with any warranty work or monitoring, all necessary permits shall be obtained from the Department.

Elective work during the warranty period will not be assessed a lane closure fee. For remedial work, costs for closure periods will be as shown in the contract.

170 During the warranty period, the Contractor may monitor the warranted micro-surfacing using non-destructive procedures.

Coring, milling or other destructive procedures may not be performed by the Contractor, without prior consent of the Department. The Contractor will not be responsible for damages to the pavement as a result of coring, milling or other destructive procedures conducted by the Department.

180 The Contractor has the first option to perform the remedial work. If, the problem requires immediate attention, as determined by the Engineer, for safety of the traveling public and the Contractor cannot perform the remedial work within 24 h of notification, the Department will perform the remedial work. The Contractor shall be responsible for all costs incurred by the Department for remedial work performed by the Department. Remedial work performed by the Department will not alter the requirements, responsibilities, or obligations of the warranty.

**411.12 Pavement Distress Indicators, Thresholds, and Remedial Work**

The Department will use the following pavement distress indicators throughout the warranty period:

- 190
- (a) Rutting – transverse displacement of the micro-surfacing.
  - (b) Delamination – physical separation of the micro-surfacing that exposes the underlying surface.
  - (c) Raveling – wearing away of the micro-surfacing.
  - (d) Skid Resistance – friction number as measured by ASTM E 274 and E 524.

The pavement threshold values for the pavement distress indicators will be evaluated for the entire length of the project for each lane. The threshold values for the pavement distress indicators are listed below:

200

Distress	Single Location	Multiple Locations
Delamination or Raveling	1/2 sq yd	1 sq yd/mi
Rut Depth	1/4 in.	average 1/4 in./mi
Friction Number*	no less than 30	average 35

\* Individual friction tests will be performed in each lane every 1/2 mi for the length of the project.

The Department may evaluate the warranted micro-surfacing during the warranty period. A final condition survey will be made by the Department and the Contractor will be notified in writing of all sections exceeding the warranty threshold at least 90 days in advance of the expiration of the warranty period.

210

If the Department determines that any threshold level has been met or exceeded and remedial work is required, the Contractor shall submit a work plan and schedule to the Engineer for approval. The Contractor shall perform the remedial work within 30 calendar days of notification of approval by the Engineer.

If, anytime during the warranty period, 30% or more of the project requires, or has received remedial work, remedial work as determined by the Department shall be performed on the entire project.

220

If remedial or elective work performed by the Contractor necessitates repair or replacement of pavement markings, adjacent lanes or roadway shoulders, the required work shall be the responsibility of the Contractor.

Warranty requirements for elective and remedial work will be limited to the life of the original contract warranty.

#### **411.13 Department Maintenance**

230

The Department may perform routine maintenance operations during the warranty period including, but not limited to, plowing, applying de-icing chemicals, repairs to safety appurtenances, pavement markings, mowing and sign maintenance. The Department, during the warranty period, will perform no routine pavement surface maintenance activities.

#### **411.14 Method of Measurement**

Warranted micro-surfacing, of the type specified, will be measured by the square yard of surface course.

Only the surface course will be measured for payment.

**411.15 Basis of Payment**

240 Warranted micro-surfacing, of the type specified, will be paid for at the contract unit price per square yard of micro-surface, warranted, of the type specified, complete in place.

Payment will be made under:

	<b>Pay Item</b>	<b>Pay Unit Symbol</b>
	Micro-Surfacing, Warranted, for Approaches, Multiple Course .....	SYS
	Micro-Surfacing, Warranted, for Approaches, Single Course .....	SYS
250	Micro-Surfacing, Warranted, Multiple Course .....	SYS
	Micro-Surfacing, Warranted, Single Course .....	SYS

The cost of all incidentals including, but not limited to, surface preparation, meeting smoothness requirements, and warranty bond shall be included in the cost of the pay items.

**411.16 Final Warranty Acceptance**

260 The Engineer will review the project in the field for any defects not addressed in the indicators and recommend a Final Warranty Acceptance. The Department will issue the Contractor a Final Warranty Acceptance letter upon completion of the warranty period and all remedial work.

**SECTION 412 – FOG SEAL**

**412.01 Description**

This work shall consist of applying asphalt emulsion to the pavement surface in accordance with 105.03.

**MATERIALS**

**412.02 Materials**

10 Materials shall be in accordance with the following:

Asphalt Emulsion, AE-F .....	902.01(b)
Fine Aggregate .....	904.02

**CONSTRUCTION REQUIREMENTS**

**412.03 Equipment**

A distributor in accordance with 409.03(a) shall be used.

20 **412.04 Weather Limitations**

Fog seal operations shall not be conducted on a wet pavement, when the ambient air or pavement temperature is below 60°F, or when other unsuitable conditions

exist, unless approved by the Engineer. Fog seal shall not be applied to travel or auxiliary lanes before May 1 or after October 1.

**412.05 Preparation of Surface**

Surfaces shall be clean and free of any foreign or loose material.

30 All castings, detector housings, and snowplowable raised pavement markers shall be covered to prevent coating with fog seal prior to application of the fog seal. These coverings shall be removed prior to opening to traffic.

**412.06 Application of Asphalt Material**

The asphalt material shall be applied uniformly at the rate of 0.10 ± 0.02 gal./sq yd. Asphalt material shall be applied in such a way as to ensure even and uniform coverage to the pavement surface.

**412.07 Protection of Surface**

40 Fine aggregate or other approved blotting material shall be applied to pedestrian crosswalks, driveways or other areas as directed by the Engineer. Brooming of ponded areas shall be required prior to opening to traffic on treated surfaces, as directed.

Traffic shall not be allowed on the freshly sealed surface until the asphalt material has sufficiently cured to prevent tracking.

**412.08 Application of Pavement Markings**

50 The fog seal shall be cured a minimum of 5 days prior to applying permanent pavement markings in accordance with 808.

**412.09 Method of Measurement**

Fog seal will be measured by the square yard complete in place.

**412.10 Basis of Payment**

Fog seal will be paid for at the contract unit price per square yard.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
60 Fog Seal.....	SYS

The costs of all asphalt materials, fine aggregate, surface preparation, and all other necessary incidentals shall be included in the cost of the pay item.

**SECTION 413 – BLANK**

**SECTION 414 - ULTRATHIN BONDED WEARING COURSE,  
WARRANTED**

**414.01 Description**

This work shall consist of furnishing materials and the placement of warranted ultrathin bonded wearing course, UBWC, in accordance with 105.03. The UBWC shall consist of surface preparation, application of asphalt emulsion and asphalt mixture. Asphalt mixture shall be produced by a Certified Hot Mix Asphalt Producer.

10

The Contractor shall be responsible for the warranted UBWC in accordance with 414.14.

**MATERIALS**

**414.02 Materials**

Materials shall be in accordance with the following:

20

Asphalt Emulsion .....	414.02(a)
Asphalt Materials	
PG Binder, PG 64-22, PG 70-22 .....	902.01(a) and 414.02(b)
PG Binder Grade .....	414.02(b)
Coarse Aggregates, Class A or Higher .....	904.03 and 414.02(c)
Fine Aggregates .....	904.02
Mineral Filler .....	904.02(f)

**(a) Asphalt Emulsion**

The requirements for asphalt emulsion shall be in accordance with the following:

30

Characteristic	Test Method	Min.	Max.
<b>Tests on Emulsion</b>			
Viscosity, Saybolt Furol @ 77°F (25°C), s	AASHTO T 59	20	100
Storage Stability Test, 24 h, % (Note 1)	AASHTO T 59		1
Sieve Test, %	AASHTO T 59		0.05
Residue by Distillation, % (Note 2)	AASHTO T 59	63	
Oil Distillate by Distillation, %	AASHTO T 59		2
Demulsibility, %	w/35 mL, 0.02 N CaCl <sub>2</sub> or	60	
	w/35 mL, 0.8% DSS		
<b>Tests on Residue from Distillation</b>			
Penetration (0.1 mm) at 25°C, 100g, 5 s	AASHTO T 49	90	150
Elastic Recovery @ 39°F (4°C), %	AASHTO T 301	58	
Notes:	1. After 24 h, the emulsion shall be a homogeneous color 2. Except maximum temperature of 400 ± 10°F 3. Organic solvent shall be from the list of Approved Solvents		

**(b) Asphalt Materials**

The PG binder grade shall be selected based on the following requirements:

PG Binder	ESAL
64-22	< 10,000,000
70-22	≥ 10,000,000

Additional requirements for the PG 70-22 binder as follows:

Characteristic	Test Method	Min.	Max.
Separation, % prepared by ASTM D 7173	AASHTO T 53		6°C
Elastic Recovery, @ 39°F (4°C), %	AASHTO T 301	60	

**(c) Coarse Aggregates**

40

Additional requirements for coarse aggregate shall also be as follows:

Characteristic	Method	Min.	Max.
Coarse Aggregate Angularity	ASTM D 5821	95/85*	
Micro-Deval Abrasion, % loss	AASHTO T 327		18

\* Denotes two faced crush requirements.

**414.03 Job Mix Formula**

The job mix formula, JMF, shall be determined for each mixture prepared by an Approved Mix Design Laboratory in accordance with 414.04. The Contractor shall submit a JMF for each mixture to the Engineer one week prior to use. The JMF shall state the maximum particle size in the mixture, and the application rate for any anti-stripping additives. No mixture will be accepted until the JMF is approved.

50

**414.04 Mix Design**

The binder content and the percentage of aggregate passing each sieve shall be in accordance with the following requirements:

Mixture Designation – Control Point (Percent Passing)			
	12.5 mm	9.5 mm	4.75 mm
Sieve Size			
3/4 in. (19.0 mm)	100.0		
1/2 in. (12.5 mm)	85.0 - 100.0	100.0	
3/8 in. (9.5 mm)	55.0 - 80.0	85.0 - 100.0	100.0
No. 4 (4.75 mm)	22.0 - 38.0	22.0 - 38.0	40.0 - 55.0
No. 8 (2.36 mm)	19.0 - 32.0	19.0 - 32.0	20.0 - 32.0
No. 16 (1.18 mm)	15.0 - 24.0	15.0 - 24.0	15.0 - 24.0
No. 30 (600 μm)	11.0 - 18.0	11.0 - 18.0	11.0 - 18.0
No. 50 (300 μm)	8.0 - 14.0	8.0 - 14.0	8.0 - 14.0
No. 100 (150 μm)	5.0 - 10.0	5.0 - 10.0	5.0 - 10.0
No. 200 (75 μm)	4.0 - 5.5	4.0 - 5.5	4.0 - 5.5

Binder Content, %, _____	4.6 - 6.1	4.8 - 6.1	5.0 - 6.3
Plan Lay Rate (lb/sq yd)* _____	90	75	65
* Plan lay rates are based on 100 lb/sq yd/in. using a mixture with a specific gravity of 2.5. Mixtures with different specific gravity will require an adjusted equivalent lay rate.			

The binder film thickness shall be a minimum of 0.4 mil. The binder content of the mix shall be determined by calculating the binder film thickness in accordance with ITM 589.

- 60      Draindown from the loose mixture shall not exceed 0.10% when tested in accordance with AASHTO T 305.

The tensile strength ratio, TSR, shall meet or exceed 80% when tested in accordance with AASHTO T 283(1). Specimens for AASHTO T 283 shall be 6 in. in diameter by  $3 \frac{3}{4} \pm \frac{1}{4}$  in. height and compacted in accordance with AASHTO T 312, except the specimens shall be compacted to 100 gyrations and resultant air voids reported for information purposes only. The compaction temperatures shall be  $300 \pm 10^{\circ}\text{F}$ .

- 70      (1) Follow AASHTO T 283 with the following exceptions:

- (a) Condition the mixture for 2 h in accordance with AASHTO R 30, Section 7.1.
- (b) Compact the Superpave Gyrotory Compactor, SGC, specimens to 100 gyrations.
- (c) Extrude the samples as soon as possible without damage to the sample.
- (d) Use AASHTO T 269 to determine the void content.
- (e) Record the void content of the specimens.
- (f) If less than 55% saturation is achieved, the procedure does not need to be repeated unless the difference in tensile strength between duplicate specimens is greater than 25 lbs/sq in.

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#### **414.05 Use of Recycled Materials**

Recycled materials may consist of reclaimed asphalt pavement, RAP, or reclaimed asphalt shingles, RAS or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. RAS shall be 100% passing the 1/2 in. (12.5 mm) sieve. RAP shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

90

Recycled materials may be used as a substitute for a portion of the new materials required to produce UBWC mixtures. The amount of total binder replaced by binder in the recycled material shall be computed as follows:



$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E} \times 100\%$$

where:

- 100      A = RAP, % Binder Content  
           B = RAP, % in Mixture  
           C = RAS, % Binder Content  
           D = RAS, % in Mixture  
           E = Total, % Binder Content in Mixture

110      RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. Post-consumer asphalt shingles shall be in accordance with AASHTO MP 15 and prepared by a processing company with an IDEM Legitimate Use Approval letter. A copy of this letter shall be submitted to the Engineer. Deleterious material present in post-consumer asphalt shingles shall be limited to the percentages stated in AASHTO MP 15. Pre-consumer and post-consumer asphalt shingles shall not be blended for use in UBWC mixtures and shall be stockpiled separately from other materials.

          The recycled material percentages shall be as specified on the JMF. UBWC mixtures utilizing recycled materials shall be limited to 25% binder replacement and shall use the specified binder grade.

120      The combined aggregate properties shall be in accordance with 904. The combined aggregate bulk specific gravity shall be determined in accordance with ITM 584 and the combined aggregate gradation shall be in accordance with 414.04.

#### **414.06 Quality Control**

          The Contractor shall produce a mixture in compliance with the JMF within the limits of the quality control tolerances. The Contractor shall maintain all quality control documentation and make a copy available to the Engineer upon request or at completion of work.

130      The Contractor shall sample the mix a minimum once per day in accordance with ITM 580, section 8.6 Truck Samples, Dense Graded HMA Mixture. The sample shall be tested for binder content and gradation prior to the next day's production.

          The Contractor shall take corrective action when the binder content exceeds  $\pm 0.5\%$  from that stated in the JMF as tested in accordance with ITM 586.

          The Contractor shall take corrective action when the aggregate gradation exceeds the following values from that stated in the JMF as tested in accordance with AASHTO T 30.

Sieve Size	Quality Control Tolerances ( $\pm$ ), %		
	Mixture Designation - Tolerances		
	12.5 mm	9.5 mm	4.75 mm
3/4 in. (19.0 mm)			
1/2 in. (12.5 mm)	5.0		
3/8 in. (9.5 mm)		5.0	
No. 4 (4.75 mm)	4.0	4.0	5.0
No. 8 (2.36 mm)	4.0	4.0	4.0
No. 16 (1.18 mm)			4.0
No. 200 (75 $\mu$ m)	1.0	1.0	1.0

140

### CONSTRUCTION REQUIREMENTS

#### 414.07 Equipment

The equipment shall be in accordance with 409.01, 409.02(a), 409.03(b) and 409.03(d)1 except as follows:

The paver shall be self-priming, designed and built for applying the UBWC. The paver shall have a receiving hopper, feed system, asphalt emulsion storage tank, a calibrated metering system for measuring the emulsion volume applied, spray bar and a heated, variable width, combination vibratory screed or a combination vibratory-tamping bar screed. The paver shall be capable of spraying the asphalt emulsion, applying the asphalt mix and leveling the surface of the mat in one pass. The screed shall have the ability to crown the pavement at the center.

150

#### 414.08 Preparation of Surface

The Contractor shall be responsible for all surface preparation to meet the requirements for warranted UBWC. All castings and detector housings not identified on the plans as being reset shall be protected prior to the application of material in accordance with 404.07, except that raised pavement markers shall be removed.

160

#### 414.09 Asphalt Emulsion

The asphalt emulsion shall be applied at a temperature recommended by the emulsion supplier. The asphalt emulsion shall be applied uniformly across the entire width of pavement to be overlaid. Equipment shall not operate on the applied asphalt emulsion before the asphalt mix is placed.

The recommended plan application rates of the asphalt emulsion are as shown in the table below. Determination of actual application rates shall be the responsibility of the Contractor.

170

Recommended Asphalt Emulsion Application Rate and Adjustment Factors for Surface Conditions			
Mixture Designation	12.5 mm	9.5 mm	4.75 mm
General application rate, gal./sq yd	0.20	0.17	0.14
Existing Surface Condition	Recommended adjustment to application rate, gal./sq yd		
PCCP, smooth or polished	-0.03	-0.03	-0.03
PCCP, broomed or textured	0	0	0
Flushed asphalt concrete surface	-0.02	-0.03	-0.03
Dense, unaged asphalt concrete surface	0	0	0
Open textured, dry, aged or oxidized asphalt concrete surface	+0.02	+0.01	+0.01
Milled asphalt concrete surface	+0.02	+0.01	+0.01

#### 414.10 Pre-Paving Meeting

A pre-paving meeting between the Engineer and Contractor will be held on-site prior to beginning work. The following shall be reviewed:

- 180
- (a) work schedule
  - (b) traffic control plan
  - (c) equipment calibrations and adjustments
  - (d) inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
  - (e) job mix formula
  - (f) Contractor's proposed emulsion and mix application rates
  - (g) QCP in accordance with ITM 803
  - (h) Contractor's authorized representative.

#### 414.11 Mixture Placement

The UBWC shall be prepared and placed at temperatures recommended by the binder supplier. Fracturing of aggregates shall be avoided.

190

#### 414.12 Mixture Finishing

Three passes of rollers capable of exerting at least 150 lb/in. and in conformance with 409.03(d)1 shall be applied to the UBWC before the material has cooled below 185°F. A release agent may be added to the water system of the rollers to prevent adhesion of the material to the roller drum. Rollers shall not operate in vibratory mode.

#### 414.13 Smoothness

200 All finished surface irregularities in excess of 1/8 in. measured with a 10 ft straightedge shall be corrected.

The lane edge shall have no more than 2 in. of horizontal variance in 100 ft.

**414.14 Warranty**

A warranty bond is to insure completion of required warranty work, including payments for all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract used to remediate any warranted distresses.

210 The Contractor shall furnish to the Engineer a warranty bond at the preconstruction conference or prior to beginning any work on the contract. The warranty bond shall be equal to 100% of the contract total for the warranted UBWC pay items, and shall be properly executed by a surety satisfactory to the Department, and shall be payable to the State of Indiana. The warranty bond shall be in effect for three years from the date of substantial completion.

Upon the final acceptance of the project, the contractual obligations of the Contractor are satisfied as long as the UBWC continues to meet or exceed the warranted values as defined herein.

220 All warranty work shall be accomplished in accordance with 414.16. At the end of the warranty period, the Contractor will be released from further warranty work or responsibility, provided all previous warranty work has been satisfactorily completed and approved by the Department.

**414.15 Conflict Resolution Team**

The scope of work for the conflict resolution team includes all issues concerning the warranted pavement relative to the quality control plan, material selection, warranted pavement evaluations, distress indicators, remedial action, and remediation plans.

230 The team will consist of two Contractor representatives, two Department representatives, and an additional person mutually agreed upon by both the Department and the Contractor. All costs for the additional person will be equally shared by the Department and the Contractor.

The team members will be identified in writing when needed and will be knowledgeable in the terms and conditions of this warranty and the methods used in the measurement and calculation of pavement distress. The team will render a final recommendation to the Chief Engineer by a majority vote. Each member has an equal vote.

240

**414.16 Warranty Work**

Elective work is performed by the Contractor at its discretion to meet the performance requirements of warranted UBWC prior to direction from the Department for the Contractor to perform remedial work.

Remedial work is performed as a result of pavement distress surveys performed by the Department.

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During the warranty period, elective work and remedial work shall be performed at no cost to the Department. Elective work shall be at the Contractor's option. The scope of all elective work or remedial work to be performed as well as materials to be used shall be proposed by the Contractor and shall be subject to approval by the Department. Prior to proceeding with any warranty work or monitoring, all necessary permits shall be obtained from the Department.

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Elective work during the warranty period will not be assessed a lane closure fee. For remedial work, costs for closure periods will be as shown in the contract.

During the warranty period, the Contractor may monitor the warranted UBWC using non-destructive procedures.

Coring, milling or other destructive procedures may not be performed by the Contractor, without prior consent of the Department. The Contractor will not be responsible for damages to the pavement as a result of coring, milling or other destructive procedures conducted by the Department.

270

The Contractor has the first option to perform the remedial work. If the problem requires immediate attention, as determined by the Engineer, for safety of the traveling public and the Contractor cannot perform the remedial work within 24 h of notification, the Department will perform the remedial work. The Contractor shall be responsible for all costs incurred by the Department for remedial work performed by the Department. Remedial work performed by the Department will not alter the requirements, responsibilities, or obligations of the warranty.

#### **414.17 Pavement Distress Indicators, Thresholds and Remedial Action**

280

The Department will use the following pavement distress indicators throughout the warranty period:

- (a) Delamination - physical separation of the UBWC that exposes the underlying surface.
- (b) Rutting - transverse displacement of the UBWC.
- (c) Raveling - wearing away of the UBWC.
- (d) Skid Resistance - friction number as measured by ASTM E 274 and E 524.

290

The pavement threshold values for the pavement distress indicators will be evaluated for the entire length of the project for each lane. The threshold values for the pavement distress indicators are listed below:

Distress	Single Location	Multiple Locations
Delamination/Raveling	1/2 sq yd	1 sq yd/mi
Rut Depth	1/4 in.	average 1/4 in./mi
Friction Number*	no less than 30	average 35

\* Individual friction tests will be performed in each lane every 1/2 mi for the length of the project.

The Department may evaluate the warranted UBWC during the warranty period. A final condition survey will be made by the Department and the Contractor will be notified in writing of all sections exceeding the warranty threshold at least 90 days in advance of the expiration of the warranty period.

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If the Department determines that any threshold level has been met or exceeded and remedial work is required, the Contractor shall submit a work plan and schedule to the Engineer for approval. The Contractor shall perform the remedial work within 30 calendar days of notification of approval by the Engineer.

If, anytime during the warranty period, 30% or more of the project requires, or has received remedial work, remedial work as determined by the Department shall be performed on the entire project.

310

If remedial or elective work performed by the Contractor necessitates repair or replacement of pavement markings, adjacent lanes or roadway shoulders, the required work shall be the responsibility of the Contractor.

Warranty requirements for all elective and remedial work will be limited to the life of the original contract warranty.

#### **414.18 Department Maintenance**

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The Department may perform routine maintenance operations during the warranty period including, but not limited to, plowing, applying de-icing chemicals, repairs to safety appurtenances, pavement markings, mowing and sign maintenance. The Department, during the warranty period, will perform no routine pavement surface maintenance activities.

#### **414.19 Method of Measurement**

Ultrathin bonded wearing course, of the type specified, will be measured by the square yard in accordance with 109.01.

#### **414.20 Basis of Payment**

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Ultrathin bonded wearing course, of the type specified, will be paid for at the contract unit price per square yard.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
Ultrathin Bonded Wearing Course for Approaches, _____ size	SYS
Ultrathin Bonded Wearing Course, _____ size	SYS

340

The cost of all incidentals including, but not limited to, surface preparation, asphalt emulsion, meeting smoothness requirements, and warranty bond shall be included in the cost of the pay items.

**414.21 Final Warranty Acceptance**

The Engineer will review the project in the field for any general defects not addressed in the indicators and recommend a Final Warranty Acceptance. The Department will issue the Contractor a Final Warranty Acceptance letter upon completion of the warranty period and all required remedial work.

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**SECTION 415 – BASE SEAL**

**415.01 Description**

This work shall consist of applying asphalt emulsion to the pavement surface in accordance with 105.03.

**MATERIALS**

**415.02 Materials**

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Base seal materials shall be in accordance with the following:

Asphalt Emulsion, SS-1h, AE-NT	902.01(b)
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**CONSTRUCTION REQUIREMENTS**

**415.03 Equipment**

A distributor in accordance with 409.03(a) shall be used.

**415.04 Weather Limitations**

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Base sealing operations shall not be conducted on a wet pavement or when the ambient air or pavement temperature is below 32°F.

**415.05 Preparation of Surface**

Surfaces shall be clean and free of any foreign or loose material.

**415.06 Application of Asphalt Material**

The base seal materials shall be applied to the pavement surface uniformly with a distributor at an application rate of 0.22 ± 0.02 gal./sq yd.

415.07

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**415.07 Protection of Surface**

The base seal materials shall cure a minimum of two hours after application before resuming paving operations.

**415.08 Method of Measurement**

The base seal will be measured by the ton complete in place.

**415.09 Basis of Payment**

The base seal will be paid for at the contract unit price per ton.

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Payment will be made under:

**Pay Item**

**Pay Unit Symbol**

Base Seal ..... TON

The costs of all asphalt materials, surface preparation and all other necessary incidentals shall be included in the cost of the pay item.