DIVISION 400 – ASPHALT PAVEMENTS

SECTION 401 – QC/QA 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

The HMA shall be produced 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 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 devices in accordance with 409.03(c) to be used for constructing the safety edge.

MATERIALS

401.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials	
PG Binder	902.01(a)
Coarse Aggregates	904.03
Base Mixtures – Class D or Higher	
Intermediate Mixtures – Class C or Higher	
Surface Mixtures* – Class B or Higher	
Fine Aggregates	904.02
Stabilizing Additives	AASHTO M 325

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

401.04 Design Mix Formula

A 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 be based on the ESAL category identified in the pay item and shall state the mixture designation and maximum particle size in the mixture. No mixture shall be used until the DMF has been assigned a mixture number by the DTE.

The DMF shall state the binder content, the ΔPb as determined in accordance with ITM 591, and the MAF. The DMF shall state the source, type, and dosage rate of any stabilizing additives.

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

ESAL Category	ESAL
2*	< 3,000,000
3	3,000,000 to < 10,000,000
4*	≥ 10,000,000
* A category 2 mixture shall replace a category 1 mixture and a category 4 mixture shall replace a category 5 mixture.	

The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 64-22 or PG 70-22 binders are used or not more than 325°F whenever PG 76-22 binder is 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 Qualified Mix Design Laboratories. A volumetric mixture shall be designed in accordance with AASHTO R 35 and the respective AASHTO reference as listed below.

All loose mixtures shall be conditioned for 4 h in accordance with AASHTO R 30 prior to testing. Steel furnace slag coarse aggregate, when used in an intermediate or base mixture application, shall have a deleterious content less than 4.0% as determined in accordance with ITM 219.

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:

Sieve Size	Dense Graded, Mixture Designation – Control Point (Percent Passing)				
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm**
2 in. (50.0 mm)					
1 1/2 in. (37.5 mm)	100.0				
1 in. (25.0 mm)	90.0 - 100.0	100.0			
3/4 in. (19.0 mm)	< 90.0	90.0 - 100.0	100.0		
1/2 in. (12.5 mm)		< 90.0	90.0 - 100.0	100.0	100.0
3/8 in. (9.5 mm)			< 90.0	90.0 - 100.0	95.0 - 100.0
No. 4 (4.75 mm)				< 90.0	90.0 - 100.0
No. 8 (2.36 mm)	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0*	
No. 16 (1.18 mm)					30.0 - 55.0
No. 30 (600 µm)					
No. 50 (300 µm)					
No. 200 (75 µm)	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	3.0 - 8.0

* The mix design gradation shall be less than or equal to 58.0% passing the No. 8 (2.36 mm) sieve for all 9.5 mm surface mixtures. The mix design gradation can be greater than 58.0% passing the No. 8 (2.36 mm) sieve when used on non-Department maintained facilities.

** The total blended aggregate gradation for the 4.75 mm mixture shall have a fineness modulus greater than or equal to 3.30 as determined in accordance with AASHTO T 27.

Primary Control Sieve, 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
PCS	4.75 mm	4.75 mm	2.36 mm	2.36 mm	n/a
PCS Control Point	40	47	39	47	n/a

Sieve Size	Open Graded, Mixture Designation – Control Point (Percent Passing)		
	OG9.5 mm	OG19.0 mm	OG25.0 mm
1 1/2 in. (37.5 mm)			100.0
1 in. (25.0 mm)		100.0	70.0 – 98.0
3/4 in. (19.0 mm)		70.0 – 98.0	50.0 – 85.0
1/2 in. (12.5 mm)	100.0	40.0 – 68.0	28.0 – 62.0
3/8 in. (9.5 mm)	75.0 – 100.0	20.0 – 52.0	15.0 – 50.0
No. 4 (4.75 mm)	10.0 – 35.0	10.0 – 30.0	6.0 – 30.0
No. 8 (2.36 mm)	0.0 – 20.0	7.0 – 23.0	7.0 – 23.0
No. 16 (1.18 mm)		2.0 – 18.0	2.0 – 18.0
No. 30 (600 µm)		1.0 – 13.0	1.0 – 13.0
No. 50 (300 µm)		0.0 – 10.0	0.0 – 10.0
No. 100 (150 µm)		0.0 – 9.0	0.0 – 9.0
No. 200 (75 µm)	0 – 6.0	0.0 – 8.0	0.0 – 8.0
% Binder	> 3.0	> 3.0	> 3.0

Dust/Calculated Effective Binder Ratio shall be 0.6 to 1.4. The Dust/Calculated Effective Binder Ratio for 4.75 mm mixtures shall be 1.0 to 2.0.

The optimum binder content shall produce a $\Delta Pb \leq 0.20$ as determined in accordance with ITM 591 and the following air voids at N_{des}:

AIR VOIDS AT OPTIMUM BINDER CONTENT								
	Dense Graded					**Open Graded**		
Mixture Designation	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	25.0 mm	19.0 mm	9.5 mm
Air Voids	5.0%	5.0%	5.0%	5.0%	5.0%	15.0% - 20.0%		12.0% - 17.0%

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 MSG shall be mass determined in water in accordance with AASHTO T 209. The BSG of the gyratory specimens shall be determined in accordance with AASHTO T 166, Method A or AASHTO T 331, if required, for dense graded and open graded mixtures.

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. 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 3.0% reclaimed asphalt shingles by weight of the total mixture is used.

The percent draindown of dense graded mixtures shall not exceed 0.30% in accordance with AASHTO T 305. 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 4 h in accordance with AASHTO R 30. The minimum 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:

(a) 2.465 for 9.5 mm mixtures

(b) 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures.

If the MAF calculation results in a value where $0.980 \leq MAF \leq 1.020$, 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.

The mixture design compaction temperature for the specimens shall be 300 ±9°F for dense graded mixtures and 260°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 4.75 mm					
< 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	8	100	160	89.0	98.0
Dense Graded 9.5 mm, 12.5 mm, 19.0 mm, and 25.0 mm					
< 3,000,000	5	30	40	91.5	97.0
3,000,000 to < 10,000,000	6	50	75	91.5	97.0
≥ 10,000,000	6	50	75	91.5	97.0
Open Graded					
All ESAL	n/a	20	n/a	n/a	n/a
* N_{ini}, N_{des}, N_{max} - definitions are included in AASHTO R 35.					

Voids in Mineral Aggregate, VMA, Criteria @ N_{des}	
Mixture Designation	Minimum VMA, %
4.75 mm	17.0
9.5 mm	16.0
12.5 mm	15.0
19.0 mm	14.0
25.0 mm	13.0
OG	n/a

140

Volume of Effective Binder, Vbe, Criteria @ N_{des}	
Mixture Designation	Minimum Vbe, %
4.75 mm	12.0
9.5 mm	11.0
12.5 mm	10.0
19.0 mm	9.0
25.0 mm	8.0
OG	n/a

Voids Filled with Asphalt, VFA, Criteria @ N_{des}	
ESAL	VFA, %
< 3,000,000	60 – 73
3,000,000 to < 10,000,000	60 – 70
≥ 10,000,000	60 – 70

Notes:
1. For 4.75 mm mixtures, the specified VFA range shall be 67% to 79%.
2. For 9.5 mm mixtures, the specified VFA range shall be 69% to 72% for design traffic levels ≥ 3,000,000 ESALs.
3. For 25.0 mm mixtures, the specified lower limit of the VFA shall be 62% for design traffic levels < 300,000 ESALs.
4. For OG mixtures, VFA is not applicable.

401.06 Recycled Materials

Recycled materials may consist of RAP or RAS or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. Before entering the plant, RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve. Before entering the plant, RAS shall be processed so that 100% will pass the 3/8 in. (9.5 mm) sieve. The RAP coarse aggregate shall pass the maximum size sieve for the mixture being produced.

RAP for the ESAL category 3 and 4 surface mixtures shall be a fine RAP with 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve. The Contractor may request the use of coarse RAP in a category 4 surface mixture up to a maximum 20.0% by volume of material retained on the No. 4 (4.75 mm) sieve. The election to use coarse RAP in a category 4 surface mixture will void the allowed use of crushed stone and gravel coarse aggregate materials in accordance with 904.03(d). SMA RAP as defined in 410.06 shall not be used in any HMA mixture.

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:

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

where:

A = RAP, % Binder Content by Mass of RAP
B = RAP, % by Total Mass of Mixture
C = RAS, % Binder Content by Mass of RAS
D = RAS, % by Total Mass of Mixture
E = Total, % Binder Content by Total Mass of Mixture.

RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. The two RAS types shall not be blended together for use in HMA mixtures.

Post-consumer asphalt shingles shall be in accordance with the following:

(a) post-consumer asphalt shingles shall be essentially nail-free,

(b) extraneous metallic materials retained on or above the No. 4 (4.75 mm) sieve shall not exceed 0.5% by mass,

(c) extraneous non-metallic materials such as glass, rubber, soil, brick, paper, wood, and plastic retained on or above the No. 4 (4.75 mm) sieve shall not exceed 1.5% by mass, and

(d) post-consumer shingles shall be prepared by a processing company with an IDEM Legitimate Use Approval letter. The approval letter shall be submitted with the DMF to the Engineer.

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	9.5 mm	12.5 mm	9.5 mm	4.75 mm
2	25.0*				25.0*			25.0*		
3	25.0*				25.0*			25.0*		
4	25.0*				25.0*			25.0*		
* The contribution of RAS to any HMA mixture shall be ≤ 3.0% by total mass of mixture and ≤ 15.0% binder replacement.										

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.

401.07 Lots and Sublots

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 sublot. Partial sublots greater than 100 t constitute a full sublot. Partial lots of four sublots or less will be added to the previous lot to create an extended lot.

401.08 Blank

401.09 Acceptance of Mixtures

Acceptance of mixtures for Vbe at N_{des}, and air voids at N_{des} for each lot will be based on tests performed by the Engineer for dense graded 9.5 mm, 12.5 mm, 19.0 mm and 25.0 mm 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 a Type D certification in accordance with 402.09 for dense graded 4.75 mm mixtures.

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 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 open graded mixtures with original pay item quantities less than 300 t, except the air voids tolerance shall be ±3.5% from the DMF.

The Engineer will randomly select the location within each sublot for sampling in accordance with ITM 802. The first 300 t of the first sublot 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.

Acceptance samples will be reduced to the appropriate size for testing in accordance with ITM 587. The binder content and gradation will be determined in accordance with ITM 571. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209.

The effective specific gravity, Gse, of the mixture will be determined in each sublot and reported from the acceptance sample testing.

The total aggregate bulk specific gravity, Gsb, value will be determined in accordance with ITM 597.

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 sublot. 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 sublot, and the BSG of the aggregate blend from the DMF as applicable. The gyratory specimens will be prepared in accordance with AASHTO T 312.

The dust/calculated effective binder ratio and the volume of effective binder in the mixture will be determined and reported from the acceptance sample testing conducted in each sublot. The volume of effective binder will be the difference between VMA and air voids. The Contractor shall take action in accordance with ITM 583 to address a dust/calculated effective binder ratio not in accordance with 401.05, a volume of effective binder in the mixture below design minimums, or a volume of effective binder in the mixture greater than 2.0% above design minimums.

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 331, if required, except samples are not required to be dried overnight. The bulk specific gravity of gyratory specimens for open graded mixtures 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%.

The Contractor shall make available the sublot quality control results within seven calendar days from the date the acceptance sample was taken.

The Engineer will make available the sublot acceptance test results after receiving the sublot quality control results from the Contractor.

Air voids, binder content and Vbe 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).

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.

A Type C certification in accordance with 916 shall be provided for the stabilizing additives for each shipment. Stabilizing additives from different manufacturers and different types of stabilizing additives shall not be intermixed.

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

Samples shall not be obtained from the following areas:

(a) Mixture placed on an approach, taper, gore area, crossover that is not placed simultaneously with the mainline.

(b) Mixture placed on a shoulder less than 8 ft in width that is not placed simultaneously with the mainline.

(c) Within 25 ft of a transverse construction joint.

(d) Areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3.

If a random location falls within this area, the Engineer will randomly select another location within the sublot for sampling. If an entire sublot falls within this area, test results from the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance. If previous or subsequent sublot results for a mixture accepted by 401.19(a) will be replicated for an entire lot, each sublot in that lot will be accepted by 401.19(b).

CONSTRUCTION REQUIREMENTS

401.10 General

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 has 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. Cedarapids HMA pavers shall be those that were manufactured in 1989 or later.

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 shall 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 performed on the pavement or shoulder areas.

HMA mixtures shall not exhibit segregation, flushing, or bleeding. Corrective action shall immediately be taken to prevent continuation of these conditions. Segregated, flushed, or bleeding HMA mixtures will be referred to the Department's Division of Materials and Tests for adjudication as a failed material in accordance with 105.03.

All mixtures that become loose and broken, mixed with dirt, or are defective in any way shall be removed and replaced in accordance with 105.03.

401.11 Preparation of Surfaces to be Overlaid

The subgrade, or subbase 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 and 302. 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.

Rubblized concrete pavements shall be primed in accordance with 405. PCCP, milled asphalt surfaces, and new and existing 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.

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

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

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 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 be less than 315°F whenever PG 64-22 or PG 70-22 binders are used or not more than 325°F whenever PG 76-22 binder is used. No mixture shall be placed on a previously paved course that has not cooled to below 175°F. For mixtures compacted in accordance with 402.15, the temperature of each mixture at the time of spreading shall not be less than 245°F.

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 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.

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 five times the maximum particle size as shown on the DMF, except 4.75 mm mixtures shall be at least 1.5 times but not more than 3 times the maximum particle size shown on the DMF.

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.

Vibratory rollers in accordance with 409.03(d)4 shall not be operated in the vibratory mode at locations indicated on the plans. Oscillatory rollers in accordance with 409.03(d)5 will be allowed for use but the vertical impact force capability shall not be used. Density acceptance shall be in accordance with 401.16.

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.

Hot poured joint adhesive in accordance with 906 shall be applied to longitudinal joints constructed between two adjacent HMA courses in the top course of dense graded intermediate mixtures and all 4.75 mm, 9.5 mm, and 12.5 mm surface mixture courses. This includes joints within the traveled way as well as between any of the following:

(a) traveled way and an auxiliary lane,
(b) traveled way and a paved shoulder, and
(c) auxiliary lane and a paved shoulder.

The material shall be heated in a jacketed, double boiler melting kettle. The kettle shall have an attached pressure feed wand system with applicator shoe.

The joint adhesive shall be applied to the face of the previously constructed edge at the joint using a wand applicator. Prior to application of the joint adhesive, the joint face shall be dry and free of loose material and foreign objects. The adhesive shall be applied on the joint face 1/8 in. thick at the temperature recommended by the manufacturer. Excess joint adhesive shall not be allowed to pool on the top of the previously constructed pavement course or the pavement to be overlaid. The application of the adhesive shall be made within the same day, but at least 30 minutes prior to construction of the longitudinal joint.

All 9.5 mm and 12.5 mm surface mixture longitudinal joints that have the joint adhesive applied shall be sealed using SS-1h, RPE, or AE-NT asphalt emulsion in accordance with 902.01(b). The sealing operation shall not begin until all density cores in accordance with 401.16 and 401.20 have been obtained and the installation of pavement corrugations, when specified in accordance with 606, has been completed.

The liquid asphalt sealant shall be a minimum width of 24 in., centered on the joint line, and shall be extended, when necessary, to provide coverage beyond the edge of the pavement corrugation. The sealant shall be applied onto a dry surface, free of any foreign or loose material, using a distributor in accordance with 409.03(a). The sealant temperature at the time of application shall be at least 135°F and shall not exceed 180°F. The ambient air and pavement temperatures at the time of application shall be greater than 32°F.

The application rate of the sealant shall be as follows:

Asphalt Emulsion	Application Rate* (gal./sq yd)
SS-1h or AE-NT	0.03 ±0.01**
RPE	0.15 ±0.01***

* The asphalt material shall not be diluted.
** Areas receiving greater than 0.04 gal./sq yd shall be lightly broomed to reduce the effects of excess sealant on the pavement surface.
*** The application rate shall be reduced when sealing milled corrugations in accordance with 606. The application rate shall be 0.11 ±0.01 gal./sq yd.

Temporary pavement markings in accordance with 801.12 shall be offset a sufficient distance from the longitudinal joint so as not to obstruct the installation of the pavement corrugations or the application of the liquid asphalt sealant.

The SS-1h or AE-NT sealant shall be cured a minimum of five days prior to applying the permanent pavement traffic markings in accordance with 808. The RPE sealant shall be cured a minimum of 48 h prior to applying the permanent pavement traffic markings in accordance with 808. Where pavement markings are to be grooved in accordance with 808.07(b)1, the minimum cure for the sealant shall not apply.

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.

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 94.0% MSG and compaction shall be in accordance with 402.15.

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 4.75 mm mixtures shall be in accordance with 402.15, except vibratory rollers shall be operated in static mode and the vertical impact force capability of oscillatory rollers shall not be used.

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

Density acceptance by cores will be based on samples obtained from two random locations selected by the Engineer within each sublot 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.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6.00 ±0.25 in. diameter pavement sample. Coring shall be completed prior to the random location being covered by the next course.

All core locations will be marked and shall be cored within two work days of placement. A 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.

Cores shall not be obtained from the following areas:

(a) Mixture placed on an approach, taper, gore area, crossover that is not placed simultaneously with the mainline.

(b) Mixture placed on a shoulder less than 8 ft in width that is not placed simultaneously with the mainline.

(c) Within 25 ft of a transverse construction joint.

(d) Within 25 ft of an acceptance sample taken in accordance with 401.09.

(e) Areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3.

If a random location falls within this area, the Engineer will randomly select another location within the sublot for coring. If an entire sublot falls within this area, test results from the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

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.

The density for the mixture will be expressed as:

$$\text{Density, \%} = \frac{\text{BSG}}{\text{MSG}} \text{ x } 100$$

where:

BSG = average bulk specific gravity
MSG = maximum specific gravity

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 331, 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 either HMA of similar or smaller size particles or bridge deck repair material from the QPL of Rapid Setting Patch Materials. The rapid setting patch material shall be mixed in a separate container and placed in the hole in accordance with the manufacturer's recommendations, consolidated by rodding, and struck-off flush with the adjacent pavement.

The Engineer's acceptance test results for each sublot will be available when the sublot 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 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

401.18 Pavement Smoothness

Pavement smoothness will be accepted by means of an inertial profiler, a 16 ft straightedge, or a 10 ft straightedge as described below.

(a) Inertial Profiler with Smoothness Pay Adjustments

When a pay item for Inertial Profiler, HMA is included in the contract, the

Contractor shall furnish, calibrate, and operate an approved inertial profiler in accordance with ITM 917 for the acceptance of longitudinal smoothness on the mainline traveled way, including adjacent acceleration or deceleration lanes, where all of the following conditions are met:

1. The posted speed is greater than 45 mph.

2. The traveled way width and slope are constant and is at least 0.5 mi in length.

3. The HMA is placed on a milled surface and the planned lay rate for a single lift is 165 lb/sq yd or greater, or the total combined planned lay rate of surface, intermediate, and base courses is 385 lb/sq yd or greater.

The profiles and International Roughness Index, IRI, results including areas of localized roughness shall become the property of the Department. The inertial profiler shall remain the property of the Contractor.

The project area will be divided into individual smoothness sections measuring 0.1 mi in length for each lane. The paving exceptions and areas exempt from inertial profiler operation will be in accordance with ITM 917.

If the posted speed limit for an entire smoothness section is less than or equal to 45 mph, the section will be exempt from Inertial Profiler 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:

1. By inertial profiler 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 inertial profiler 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

The Contractor shall furnish and operate a 16 ft straightedge in accordance with 306.03(d) and as described below. The 16 ft straightedge shall be used to measure smoothness along the direction of mainline traffic.

Locations on the pavement surface scraped by the straightedge shall be marked. The pavement shall be corrected in accordance with 401.18(e) to meet the required tolerance. For existing utility and manhole castings that required no grade adjustment, the tolerance may be adjusted after being reviewed and approved by the Engineer.

For contracts which include the Inertial Profiler, HMA pay item, the 16 ft straightedge or the Inertial Profiler simulating the 16 ft straightedge shall be used to measure longitudinal smoothness on surface courses at the following locations:

1. All mainline traveled way lanes shorter than 0.5 mi.

2. All mainline traveled way lanes at locations exempted from inertial profiler operation in accordance with ITM 917.

3. All mainline traveled way lanes within smoothness sections with posted speed limits less than or equal to 45 mph throughout the entire section length.

4. All tapers.

5. All ramps.

6. All turn lanes, including bi-directional left turn lanes shorter than 0.5 mi.

7. All acceleration and deceleration lanes associated with ramps with posted speeds of 45 mph or less.

8. All shoulders.

9. All intersections with significant change in cross slope.

For contracts where the inertial profiler is not used for smoothness acceptance, the 16 ft straightedge shall be used to measure longitudinal smoothness on all surface courses, and on any dense graded intermediate course immediately below the surface course. Measurement with the 16 ft straightedge shall include the above locations, all mainline traveled way lanes and ramps with posted speeds greater than 45 mph, and on ramp acceleration or deceleration lanes.

(c) 10 ft Straightedge

The 10 ft straightedge will be in accordance with 306.03(d). The 10 ft straightedge will be used to check transverse slopes, across travel lanes and shoulders, approaches, and crossovers. When the 10 ft straightedge is used, the pavement variations shall be corrected to 1/8 in. or less.

(d) Areas of Localized Roughness, ALR

At locations where the inertial profiler is being used on an intermediate course,

all areas having a localized roughness in excess of 160 in./mi utilizing continuous IRI with a 25 ft window shall be corrected subject to approval by the Engineer.

At locations where the inertial profiler is being used on a surface course, all areas under category Type A, as defined in 401.19(c), having a localized roughness in excess of 160 in./mi or category Type B in excess of 170 in./mi utilizing continuous IRI with a 25 ft window shall be corrected subject to approval by the Engineer. After ALR's have been identified, a grinding simulation shall be performed to estimate whether the ALR can be corrected to an IRI value of less than 160 in./mi with no more than a 1/4 in. max grind depth at any spot. If such correction is not possible, then an ALR with an IRI value of less than 190 in./mi can remain uncorrected if approved by the Engineer, and an ALR with an IRI value greater than 190 in./mi shall require full depth removal and replacement of the surface course of sufficient area to meet specifications.

In addition, if there is only one ALR in any two lane mile section, then no smoothness correction will be required if the ALR does not exceed 190 in./mi and the overall smoothness in accordance with 401.18(d) of the two lane mile section does not require any corrective action. A two lane mile section will start one mile before the ALR and end one mile after the ALR in order that all two lane mile sections will have, at most, one ALR each.

(e) Smoothness Section Correction

The width of the corrected area may be partial or full lane width, depending on the respective wheel path profiles. 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 inertial profiler shall be operated throughout the entire affected smoothness section to verify the adequacy of the corrective action.

At locations where the 16 ft straightedge is used, the pavement variations shall be corrected to 1/4 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 ≥ One Lot

Pay factors, PF, are calculated for the air voids at N_{des}, Vbe 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:

$$PF = ((0.50 \times PWL) + 55.00)/100$$

Estimated PWL greater than 70 and equal to or less than 90:

$$PF = ((0.40 \times PWL) + 64.00)/100$$

760

Estimated PWL greater than or equal to 50 and equal to or less than 70:

$$PF = ((0.85 \times PWL) + 32.5)/100$$

If the Lot PWL for any one of the properties is less than 50, a sublot has an air void content less than 1.0% or greater than 8.0%, or a sublot has a volume of effective binder greater than 3.0% above design minimums, the lot will be referred to the Department's Division of Materials and Tests for adjudication as a failed material in accordance with normal Department practice as listed in 105.03.

770

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

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

$$\text{Lot PF} = 0.30(PF_{VOIDS}) + 0.35(PF_{Vbe}) + 0.35(PF_{DENSITY})$$

where:

Lot PF = Lot Composite Pay Factor for Mixture and Density
PF_{VOIDS} = Lot Pay Factor for Air Voids at N_{des}
PF_{Vbe} = Lot Pay Factor for Vbe at N_{des}
$PF_{DENSITY}$ = Lot Pay Factor for In-Place Density, % Gmm

780

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

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

where:

q = quality assurance adjustment for mixture properties and density of the lot
L = Lot quantity
U = Unit price for the material, $/ton
Lot PF = Lot Pay Factor

Lot test results for the air voids at N_{des}, Vbe at N_{des}, and density will be used to determine the Lot Pay Factors.

790

The specification limits for the air voids at N_{des}, Vbe at N_{des}, and density will be as follows:

SPECIFICATION LIMITS		
Mixture		
	LSL*	USL**
Air Voids at N_{des}, %	3.60	6.40
Volume of Effective Binder at N_{des}, %	Spec	Spec +2.50
Density		
	LSL*	USL**
Roadway Core Density (%Gmm), %	93.00	n/a
* LSL, Lower Specification Limit ** USL, Upper Specification Limit		

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

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

800 Dense Graded Mixture:

$$SCPF = 0.30(PF_{VOIDS}) + 0.35(PF_{Vbe}) + 0.35(PF_{DENSITY})$$

Open Graded Mixture:

$$SCPF = 0.20(PF_{BINDER}) + 0.35(PF_{VOIDS}) + 0.45$$

where:

$SCPF$ = Sublot Composite Pay Factor for Mixture and Density
PF_{BINDER} = Sublot Pay Factor for Binder Content
PF_{VOIDS} = Sublot Pay Factor for Air Voids at N_{des}
PF_{Vbe} = Sublot Pay Factor for Vbe at N_{des}
$PF_{DENSITY}$ = Sublot Pay Factor for Density

810

If the SCPF for an open graded sublot is less than 0.85 or the volume of effective binder is greater than 3.0% above design minimums, the sublot will be referred to the Division of Materials and Tests for adjudication as a failed material in accordance with 105.03.

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

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

820 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	
Open Graded Deviation from DMF (±%)	Pay Factor
≤ 0.2	1.05
0.3	1.04
0.4	1.02
0.5	1.00
0.6	0.90
0.7	0.80
0.8	0.60
0.9	0.30
1.0	0.00
>1.0	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.	

VOLUME OF EFFECTIVE BINDER, Vbe	
Dense Graded Deviation from Spec Minimum	Pay Factors
> +3.0	Submitted to the Division of Materials and Tests*
≥ +2.5 and ≤ +3.0	1.00 - 0.05 for each 0.1% above +2.5%
≥ +2.0 and < +2.5	1.05 - 0.01 for each 0.1% above +2.0%
> +0.5 and < +2.0	1.05
≥ 0.0 and ≤ +0.5	1.05 - 0.01 for each 0.1% below +0.5%
≥ -0.5 and < 0.0	1.00 - 0.02 for each 0.1% below 0.0%
≥ -2.0 and < -0.5	0.90 - 0.06 for each 0.1% below -0.5%
< -2.0	Submitted to the Division of Materials and Tests*
* 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 Spec (±%)	Deviation** (±%)	
≤ 0.5	≤ 3.0	1.05
> 0.5 and ≤ 1.7	> 3.0 and ≤ 4.0	1.00
	4.1	0.98
1.8	4.2	0.96
	4.3	0.94
	4.4	0.92
1.9	4.5	0.90
2.0	4.6	0.84
	4.7	0.78
	4.8	0.72
	4.9	0.66
	5.0	0.60
> 2.0	> 5.0	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. ** Deviation shall be from 17.5% for OG25.0 mm and OG19.0 mm mixtures and shall be from 14.5% for OG9.5 mm mixtures.		

830

For mixtures produced during a plant's adjustment period, pay factors based on the DMF 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:

DENSITY	
Percentages are based on %MSG	Pay Factors, %
Dense Graded	
≥ 98.0	Submitted to the Division of Materials and Tests*
97.0 - 97.9	1.00
96.6 - 96.9	1.05 - 0.01 for each 0.1% above 96.5
95.0 - 96.5	1.05
94.1 - 94.9	1.00 + 0.005 for each 0.1% above 94.0
93.0 - 94.0	1.00
92.0 - 92.9	1.00 - 0.005 for each 0.1% below 93.0
91.0 - 91.9	0.95 - 0.010 for each 0.1% below 92.0
90.0 - 90.9	0.85 - 0.030 for each 0.1% below 91.0
≤ 89.9	Submitted to the Division of Materials and Tests*
* 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 an inertial profiler in accordance with 401.18(a).

The Mean Roughness Index, MRI, will be determined utilizing a fixed interval for each lane for each 0.1 mile section of paving. The MRI for a 0.1 mile section will be the average of the IRI of the two wheel paths. Categorized segments shall be as follows:

1. Type A. Pavement on a non-interstate with more than a single opportunity to achieve a smooth ride or asphalt pavement on an interstate with a single opportunity or more. The following operations, if performed on the contract, will be considered opportunities.

   a. A layer of HMA base, intermediate, and surface; each layer is an opportunity. Wedge and level will not be considered an opportunity.

   b. Profile milling to correct cross slope is considered an opportunity prior to placing base, intermediate, or surface HMA.

2. Type B. Pavement that is not included in the description above under Type A.

At locations where an inertial profiler is used to accept smoothness, a quality assurance adjustment will be determined for each lane. This adjustment will be applied to all QC/QA HMA pay items within the pavement section. The adjustment 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:

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
S = planned spread rate for material, lb/sq yd
T = conversion factor: 2,000 lb/ton
U = unit price for the material, $/ton.

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:

$$Q_s = \sum q_s$$

880 When smoothness is measured by an inertial profiler, payment adjustments will be made for any 0.1 mile section based on initial MRI generated on the surface course only and in accordance with the following table. Smoothness correction, if required, shall be in accordance with 401.18(e). The MRI pay factors for smoothness will be determined prior to any required smoothness correction.

PAY FACTORS FOR SMOOTHNESS Posted Speed greater than 45 mph	
MRI, in./mi.	Pay Factor, PF
over 0 to 35	1.06
over 35 to 40	1.05
over 40 to 45	1.04
over 45 to 50	1.03
over 50 to 55	1.02
over 55 to 60	1.01
over 60 to 70	1.00
over 70 to 75	0.99
over 75 to 80	0.98
over 80 to 85	0.96
over 85 to 90	0.95
over 90	For Type A, PFs will be 0.95 and the section shall be corrected to 70 or less.
over 90 to 110	For Type B, PFs will be 0.95 and the section does not require correction.
over 110	For Type B, PFs will be 0.95 and the section shall be corrected to 90 or less.

401.20 Appeals

890 **(a) Dense Graded Mixtures and Open Graded Mixtures**

If the QC test results do not agree with the acceptance test results in a sublot, a request, along with a comparison of the QC and acceptance test results, may be made in writing for additional testing of that sublot. The appeal sample will be analyzed in

a lab different than the lab that analyzed the original sample at the discretion of the Engineer.

The Contractor may appeal an individual sublot for the binder content, the MSG, the BSG of the gyratory specimens, or the BSG of the density cores when the QC results are greater than one standard deviation from the acceptance test results as follows: 0.25 for binder content, 0.010 for the MSG and BSG of the gyratory specimens, and 0.020 for the BSG of the density cores.

Upon request from the Contractor, the BSG of the density core may be exempted from the individual sublot appeal if both the QC and QA results show a %MSG for the density greater than or equal to 93.0%.

A $500.00 credit adjustment will be included in a quality adjustment pay item in accordance with 109.05.1(d) for each appealed sublot that did not result in an improvement to the SCPF or Lot PF.

A written request for an appeal 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 sublot accepted under 401.19(b). The conditions for an extended lot appeal are as follows:

(1) one appeal will be allowed for the entire extended lot if the Contractor informs the Department of the anticipated extended lot condition within seven calendar days of receipt of the lot results, or

(2) one appeal will be allowed only for the extended sublots if the Contractor did not inform the Department of the anticipated extended lot condition within seven calendar days of receipt of the lot results.

The backup sample will be tested in accordance with the applicable test method for the sublot requested for all tests exceeding the sublot standard deviation criteria.

1. MSG

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

2. BSG of the Gyratory Specimen

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

3. Binder Content

The backup binder content sample will be prepared and tested in accordance with ITM 571.

4. BSG of the Density Core

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 331, 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.

(b) Smoothness

The Department will perform annual Quality Assurance reviews of a portion of each Contractor's MRI results in accordance with ITM 917. The Contractor's results will be compared to the Department's. The Department will notify the Contractor of unacceptable results in a timely manner. The Department will allow an appeal period of 14 days during which time the Contractor shall submit a written request and appeal results for Department review. If the Contractor's appeal results do not agree with the Department's results, the Contractor shall be required to perform a side-by-side evaluation. The Department's results will be utilized for smoothness payment in place of the Contractor's results unless the Contractor's appeal results are determined to be acceptable for payment. Sections where corrective action has taken place prior to the Department's data collection will utilize the Contractor's initial results prior to corrective action for payment.

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.

Milled shoulder corrugations will be measured in accordance with 606.02.

Joint adhesive will be measured by the linear foot in accordance with 109.01(a). Liquid asphalt sealant will be measured by the linear foot.

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, operating the inertial profiler, and furnishing IRI profile information will be made at the contract lump sum price for Inertial Profiler, HMA.

Furnishing and operating the 16 ft straightedge shall be included in the cost of other pay items within this section.

Adjustments to the contract payment with respect to mixture, density, and smoothness for the 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.

Joint adhesive will be paid for at the contract unit price per linear foot, complete in place. Liquid asphalt sealant will be paid for at the contract unit price per linear foot.

Payment will be made under:

Pay Item	Pay Unit Symbol
Inertial Profiler, HMA	LS
Joint Adhesive, _____ (course type)	LFT
Liquid Asphalt Sealant	LFT
QC/QA-HMA, _____, _____, _____, _____mm (ESAL[1]) (PG[2]) (Course[3]) (Mix[4])	TON

[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

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.

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 Inertial Profiler, HMA will be full compensation regardless of how often the inertial profiler is used or how often the IRI is determined.

If QC/QA-HMA 19.0 mm over QC/QA-HMA 25.0 mm mixtures are specified, QC/QA-HMA 19.0 mm mixture may be considered as a substitute for the QC/QA-HMA 19.0 mm and QC/QA-HMA 25.0 mm 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 19.0 mm mixture. The quantity and amount for QC/QA-HMA 19.0 mm mixture shall equal the sum of the contract quantities and amounts shown for QC/QA-HMA 19.0 mm and QC/QA-HMA 25.0 mm mixtures. The unit price for QC/QA-HMA 19.0 mm mixture shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the QC/QA-HMA 19.0 mm mixture will be made at the unit price per ton for QC/QA-HMA 19.0 mm mixture. No payment will be made for additional work or costs which may result due to this change.

SECTION 402 – 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 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 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 401.04 and submitted in a format acceptable to the Engineer one week prior to use.

The DMF will be based on the ESAL and mixture designation as follows:

Mixture Type	**Type B***	**Type C**	**Type D**
Design ESAL	< 3,000,000	3,000,000 to < 10,000,000	≥ 10,000,000
Surface	4.75 mm	4.75 mm	4.75 mm
	9.5 mm	9.5 mm	9.5 mm
	12.5 mm	12.5 mm	12.5 mm
Surface – PG Binder	64-22	70-22	70-22
Intermediate	9.5 mm	9.5 mm	9.5 mm
	12.5 mm	12.5 mm	12.5 mm
	19.0 mm	19.0 mm	19.0 mm
	25.0 mm	25.0 mm	25.0 mm
Intermediate – PG Binder	64-22	64-22	70-22
Base	19.0 mm	19.0 mm	19.0 mm
	25.0 mm	25.0 mm	25.0 mm
Base – PG Binder	64-22	64-22	64-22
*A Type B mixture shall replace a Type A mixture.			

A Type C mixture may be used in lieu of a Type B mixture. A Type D mixture may be used in lieu of a Type C or a Type B mixture.

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 64-22 or PG 70-22 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.

No mixture shall be used until the DMF has been assigned a mixture number by the DTE.

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. The high temperature grade shall meet the minimum requirements of 402.04.

The MAF equals the G_{mm} from the mixture design divided by the following:

(a) 2.465 for 9.5 mm mixtures

(b) 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures.

If the MAF calculation results in a value where $0.980 \leq MAF \leq 1.020$, 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 Blank

402.07 Mix Criteria

(a) Composition Limits for HMA Transverse Rumble Strip Mixtures

Transverse rumble strip mixtures shall be Type B surface in accordance with 402.04. An 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

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. An MAF in accordance with 402.05 will not apply.

(d) Composition Limits for HMA Curbing Mixes

The mixture shall be HMA surface Type B 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 binder content.

402.08 Recycled Materials

Recycled materials shall be in accordance with 401.06, except Type B mixtures

shall correspond to category 2 mixtures, Type C mixtures shall correspond to category 3 mixtures, and Type D mixtures shall correspond to category 4 mixtures.

402.09 Acceptance of Mixtures

A Type D certification in accordance with 916 and the Frequency Manual shall be provided for the HMA pavement. 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 ±2.0% and binder content tolerance shall be ±0.7% from DMF.

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 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 performed on the pavement or shoulder areas.

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 defective in any way 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.

402.11 Preparation of Surfaces to be Overlaid

The subgrade, or subbase, 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 and 302. 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.

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.

402.12 Weather Limitations

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.

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

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 a mixture is produced from more than one DMF 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 be less than 315°F whenever PG 64-22 or PG 70-22 binders are used. The temperature of each mixture at the time of spreading shall not be less than 245°F. No mixture shall be placed on a previously paved course that has not cooled to less than 175°F.

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.

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.

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.

The finished thickness of each course shall be at least two times but not more than five times the maximum particle size as shown on the DMF. 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. Feathering may be less than the minimum thickness requirements.

Transverse rumble strips shall be placed to ensure uniformity of height, 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.

Vibratory rollers in accordance with 409.03(d)4 shall not be operated in vibratory mode at locations indicated on the plans. Oscillatory rollers in accordance with 409.03(d)5 will be allowed for use but the vertical impact force capability shall not be used. Density acceptance shall be in accordance with 402.15.

402.14 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.

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

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.

250

NUMBER OF ROLLER APPLICATIONS							
Rollers	Courses						
	≤ 440 lb/sq yd					> 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.

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.

260 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.

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.

270 (b) For unconfined edges, the compaction equipment shall extend 6 in. beyond the edge of the hot mat.

All displacement of the HMA mixture shall be corrected at once using 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 of the compaction equipment 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.

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.

Transverse 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

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 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.

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 6.00 ±0.25 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.

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.

The density for the mixture shall be expressed as:

$$\text{Density, \%} = \frac{\text{BSG}}{\text{MSG}} \times 100$$

where:

BSG = average bulk specific gravity
MSG = maximum specific gravity

The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166, Method A or AASHTO T 331, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. Density shall not be less than 93.0%.

The Contractor shall refill the core holes in accordance with 401.16.

402.17 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

402.18 Pavement Smoothness

Pavement smoothness will be in accordance with 401.18, except inertial profiler 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.

Milled pavement 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 transverse rumble strips will be paid for at the contract unit price per linear foot, complete in place.

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

Payment will be made under:

Pay Item	Pay Unit Symbol
HMA Transverse Rumble Strips	LFT
HMA for Temporary Pavement, Type __*__	TON

HMA Wedge and Level, Type __*__..... TON
* Mixture type

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.

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.

The cost of removal of HMA for temporary pavement including the subgrade and subbase materials shall be included in the cost of HMA for temporary pavement.

SECTION 403 – BLANK

SECTION 404 – SEAL COAT

404.01 Description

This work shall consist of one or more applications of asphalt material, each followed by an application of cover aggregate in accordance with 105.03.

404.02 Quality Control

Seal coat, SC, shall be constructed according to a QCP prepared and submitted by the Contractor in accordance with ITM 803, Contractor Quality Control Plan for Seal Coat.

The QCP shall be submitted to the Engineer at least 15 days prior to commencing seal coat operations.

MATERIALS

404.03 Asphalt Material

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

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

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, 12, SC 11, SC 12, or SC 16.....904.03
Fine Aggregate, Size No. 23 or 24 .....904.02
* Coarse aggregate type required shall be in accordance with 904.03(d)1 for ESAL categories 2 or 3.

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, SC 12	14 - 17	0.29 - 0.33
3 or 3P	Single	11, SC 11, SC 16	16 - 20	0.36 - 0.40
4 or 4P	Single	9	28 - 32	0.63 - 0.68
5 or 5P	Double	Top: 12, SC 12 Bottom: 11, SC 11, SC 16	16 - 19 16 - 20	0.41 - 0.46 0.28 - 0.31
6 or 6P	Double	Top: 11, SC 11, SC 16 Bottom: 9	18 - 22 28 - 32	0.62 - 0.68 0.42 - 0.46
7 or 7P	Double	Top: 11, SC 11, SC 16 Bottom: 8	18 - 22 28 - 32	0.62 - 0.68 0.42 - 0.46

Note 1 – AE-90S and SC aggregates shall be used for Type P seal coats, except SC aggregate requirement will not apply to seal coat used on shoulders.
Note 2 – HFRS-2 shall not be used with Type 1 seal coat.

SC aggregates shall be 85% one face and 80% two face crushed. The Flakiness Index in accordance with ITM 224 shall be a maximum of 25%. Non SC aggregates shall have a minimum crushed particle percentage of 70%. Determination of crushed particles shall be made from the mass weight of material retained on the No. 4 (4.75 mm) sieve in accordance with ASTM D5821.

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.

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.

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

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 can be covered with the cover aggregate within the trucks at the site.

The spread of the asphalt material shall be no wider than the width covered by the cover aggregate from the spreading device. Operations shall allow asphalt materials 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

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

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 101.36.

404.12 Protection of Surface

Traffic shall not be allowed on the freshly sealed surfaces until final rolling application is complete. The seal coat shall be protected by keeping traffic off the freshly sealed surface or by controlling traffic speed in accordance with the QCP. Traffic shall not displace the embedded aggregate.

Any areas with minor bleeding will be covered with fine aggregate or other approved blotting material.

404.13 Method of Measurement

Seal coat will be measured by the square yard of the seal coated surface.

Patching will be measured in accordance with 304.06.

404.14 Basis of Payment

Seal coat will be paid for at the contract unit price per square yard complete in place.

Patching will be paid for in accordance with 304.07.

Payment will be made under:

Pay Item	Pay Unit Symbol
Seal Coat, _____ (type)	SYS
Seal Coat, _____ (type) P	SYS

The cost of determination of asphalt material and cover aggregate application rates, sweeping and rolling operations, blotting material, and other incidentals shall be included in the cost of the pay items.

The Contractor shall adjust application rates as directed by the Engineer within the limits set out herein. No additional payment will be made for additional materials necessary to meet the required application rates within the specified limits.

SECTION 405 – PRIME COAT

405.01 Description

This work shall consist of preparing and treating a rubblized PCCP with asphalt material in accordance with 105.03.

MATERIALS

405.02 Asphalt Materials

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

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

405.03 Cover Aggregate

Aggregate shall be in accordance with the following:

Coarse Aggregate, Class B or Higher, Size No. 12 ..... 904.03
Fine Aggregate, Size No. 23 or No. 24..... 904.02

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

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

AE-PL 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

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.

Payment will be made under:

Pay Item	Pay Unit Symbol
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

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

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

CONSTRUCTION REQUIREMENTS

406.03 Equipment

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. The surface where the asphalt material is applied shall be free of standing water and shall be cleaned of dust, debris and any substances that will prevent adherence.

406.05 Application of Asphalt Material

The asphalt material shall be uniformly applied across the entire width of pavement to be overlaid and shall cover a minimum of 95% of the surface. The asphalt

material shall be given sufficient time to break and set to minimize tracking from hauling and laydown equipment. Areas of inadequate coverage that create streaking or areas of excessive coverage that create ponding shall be corrected to obtain an even distribution.

The asphalt material application rate shall be based on the existing surface type and shall be as follows:

Surface Type	Application Rate*(gal./sq yd)
New Asphalt	0.05 to 0.08
Existing Asphalt	0.06 to 0.11
Milled Asphalt	0.06 to 0.12
PCCP	0.05 to 0.08
* The asphalt material shall not be diluted.	

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.

Payment will be made under:

Pay Item	Pay Unit Symbol
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.

407.02 Asphalt Material

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

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

407.03 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.

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
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 full section width 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.

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:

Pay Item	Pay Unit Symbol
Asphalt for Dust Palliative	TON

SECTION 408 – SEALING OR FILLING CRACKS AND JOINTS

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

Full lane width transverse cracks and longitudinal joints shall be routed and sealed. All other cracks shall be filled.

MATERIALS

408.02 Materials
Materials shall be in accordance with the following:

Asphalt Binder, PG 64-22* ..... 902.01(a)

Asphalt Emulsion for Crack Filling, AE-90S.....902.01(b)
Fine Aggregates, No. 23 or No. 24.....904.02
Joint Sealing Materials .....906.02(a)2

* A PG 64-22 asphalt binder shall be used to fill cracks on a surface that is milled in accordance with 306, and polypropylene fibers shall be used only in conjunction with warranted micro-surfacing.

CONSTRUCTION REQUIREMENTS

408.03 Equipment

A distributor in accordance with 409.03 shall be used when crack filling with asphalt emulsion or an indirect-heat double boiler kettle with mechanical agitator shall be used when filling with hot poured material. An indirect-heat double boiler kettle with mechanical agitator shall be used when routing and sealing. 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 approved by the Engineer.

408.05 Routing and Sealing Cracks and Joints

Cracks and joints, 1/2 in. or less in width, shall be routed 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. Cracks and joints shall be cleaned by blowing with compressed air or by other suitable means. 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 sealed with hot poured joint sealant to within 1/4 in. below the surface in accordance with the manufacturer's recommendations.

408.06 Filling Cracks

Cracks 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. The cracks 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 filled cracks shall be covered with sufficient fine aggregate or other suitable material to prevent tracking of the asphalt materials. All excess cover material shall be removed from the pavement within 24 h, when directed.

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.

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:

Pay Item	Pay Unit Symbol
Cracks and Joints in Asphalt Pavement, Rout and Seal	TON
Cracks in Asphalt Pavement, Fill	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 certified in accordance with ITM 583 and shall be capable of producing a uniform mixture.

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.

Distributors shall also be equipped with a power unit for the pump and 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.

Truck beds may be treated with anti-adhesive agents selected from the QPL. 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 QPL of 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, 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) Advant-Edge™, Advant-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 backlashing. 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.

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 an average contact pressure from 50 to 90 psi uniformly over the pavement.

The wheels on at least one axle shall be fully oscillating vertically and mounted 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.

4. Vibratory Roller

A vibratory roller shall have 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 shall have 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.

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.

(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

The inertial profiler shall be in accordance with ITM 917.

SECTION 410 – QC/QA HMA – SMA PAVEMENT

410.01 Description

This work shall consist of one course of QC/QA HMA – 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 the 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.

MATERIALS

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	904.03
Fine Aggregates (sand, mineral filler)	904.02
Stabilizing Additives	AASHTO M 325

410.04 Design Mix Formula

A 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, ΔPb, determined in accordance with ITM 591, the aggregate degradation loss value in accordance with ITM 220 and a Mixture Adjustment Factor, MAF. The DMF shall state the source, type dosage rate of any stabilizing additives. The DMF will be based on the ESAL and mixture designation. No mixture shall be used until the DMF has been assigned a mixture number by the DTE.

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

ESAL Category	ESAL
2*	< 3,000,000
3	3,000,000 to < 10,000,000
4*	≥ 10,000,000
* A category 2 mixture shall replace a category 1 mixture and a category 4 mixture shall replace a category 5 mixture.	

The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 70-22 binder is used or not more than 325°F whenever PG 76-22 binder is 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 Qualified Mix Design Laboratories. A SMA mixture shall be designed in accordance with ITM 220, AASHTO M 325 and AASHTO R 46 except the design gyrations shall be 75 for all ESAL categories. All loose mixture shall be conditioned for 4 h in accordance with AASHTO R 30 prior to testing. Steel furnace slag coarse aggregate, when used in an intermediate mixture application, shall have a deleterious content less than 4.0% as determined in accordance with ITM 219.

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

SMA GRADATION CONTROL LIMITS						
	Mixture Designation					
	9.5 mm		**12.5 mm**		**19.0 mm**	
Sieve Size	Lower	Upper	Lower	Upper	Lower	Upper
1 1/2 in. (37.5 mm)					100.0	100.0
1 in. (25.0 mm)			100.0	100.0	99.0*	100.0
3/4 in. (19.0 mm)	100.0	100.0	99.0*	100.0	90.0	99.0
1/2 in. (12.5 mm)	99.0*	100.0	90.0	99.0	50.0	88.0
3/8 in. (9.5 mm)	70.0	95.0	50.0	80.0	25.0	60.0
No. 4 (4.75 mm)	30.0	50.0	20.0	35.0	20.0	28.0
No. 8 (2.36 mm)	20.0	30.0	16.0	24.0	16.0	24.0
No. 16 (1.18 mm)	---	21.0	---	---	---	---
No. 30 (600 µm)	---	18.0	---	---	---	---
No. 50 (300 µm)	---	15.0	---	---	---	---
No. 200 (75 µm)	8.0	12.0	8.0	11.0	8.0	11.0
* The lower % passing gradation may be 98.0% when SMA RAP material in accordance with 410.06 is used in the SMA mixture.						

The optimum binder and aggregate gradation content shall produce a $\Delta Pb \leq 0.20$ as determined in accordance with ITM 591 and 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 mixture shall not exceed 0.30% in accordance with AASHTO T 305.

The MAF equals the Gmm from the mixture design divided by the following:

(a) 2.465 for 9.5 mm mixtures

(b) 2.500 for 12.5 mm and 19.0 mm mixtures.

If the MAF calculation results in a value where $0.980 \leq MAF \leq 1.020$, 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.

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 4 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 ±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.

A change in the source or types of aggregates or a change in source or type of stabilizing additives shall require a new 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 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 DTE. A new DMF is not required for this adjustment.

The mixture design compaction temperature for the specimens shall be 300 ±9°F.

Voids in Mineral Aggregate, VMA, Criteria	
Mixture Designation	Minimum VMA, %
19.0 mm	15.0
12.5 mm	16.0
9.5 mm	17.0

410.06 Recycled Materials

Recycled materials shall be in accordance with 401.06 for dense graded mixtures except non-SMA RAP material for use in the SMA mixture shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

SMA RAP material shall be the product derived by exclusively milling an existing SMA mixture. The SMA RAP material shall pass the maximum size sieve for the mixture being produced as follows:

SMA RAP GRADATION, %						
Sieve Size	Mixture Designation					
	9.5 mm		**12.5 mm**		**19.0 mm**	
	Lower	Upper	Lower	Upper	Lower	Upper
1 1/2 in. (37.5 mm)					100.0	100.0
1 in. (25.0 mm)			100.0	100.0	95.0	100.0
3/4 in. (19.0 mm)	100.0	100.0	95.0	100.0	---	---
1/2 in. (12.5 mm)	95.0	100.0	---	---	---	---

The Contractor may request the use of SMA RAP material in the SMA mixture provided the material is stockpiled separately at the plant and the material properties were determined in accordance with ITM 584 during stockpile construction. The request shall include all QC test results describing the stockpile composition. The

Engineer will obtain a representative sample of the SMA RAP material in accordance with ITM 207 for testing in accordance with ITM 590 to verify the proposed design value.

410.07 Lots and Sublots

Lots will be defined as 4,000 t of SMA intermediate mixture or 2,400 t of SMA surface mixture. Lots will be further sub-divided into sublots not to exceed 1,000 t of SMA intermediate mixture or 600 t of SMA surface mixture. Partial sublots of 100 t or less will be added to the previous sublot. Partial sublots greater than 100 t constitute a full sublot.

410.08 Job Mix Formula

A JMF shall be developed by a certified HMA producer in accordance with ITM 583. A JMF used for SMA mixture in the current calendar year will be allowed.

The aggregate and recycled materials blend percentage and the amount passing all sieves on the DMF may be adjusted provided the gradation limits do not exceed the requirements of 410.05. Adjustments to the aggregate and recycled materials blend percentage, gradation and the new combined aggregate bulk specific gravity shall be included on the JMF.

The total binder content on the JMF may be determined by adjusting the DMF a maximum of ±0.3%. The recycled materials binder content may be adjusted as part of the total binder content provided the binder replacement percentage is in accordance with 410.06.

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.

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 sublot 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.

Samples from each location shall be obtained from each sublot 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.

The Engineer will make the sublot acceptance test results available after receiving the sublot quality control results from the Contractor.

ACCEPTANCE TOLERANCE FOR MIXTURES (Percent Mass)									
Mixture	Number of Tests	Sieve Size							
		*25.0 mm	*19.0 mm	*12.5 mm	*9.5 mm	*4.75 mm	2.36 mm	600 µm	75 µm
Surface	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
Intermediate	1	---	---	---	---	---	10.0	6.0	2.0
	2	---	---	---	---	---	7.0	4.2	1.4
	3	---	---	---	---	---	5.8	3.5	1.2
	4	---	---	---	---	---	5.0	3.0	1.0
* 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 sublot 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).

ACCEPTANCE TOLERANCE FOR RANGE (±Percent Mass)		
Sieve Size and Binder Content	Percentage Points	
	Surface	Intermediate
No. 8 (2.36 mm)	12.0	15.0
No. 30 (600 µm)	6.0	9.0
No. 200 (75 µm)	2.0	3.0
% Binder	1.0	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 sublot. The range of binder shall be the difference between the highest sublot binder content and the lowest sublot binder content in one

lot. The range of gradation shall be the difference between the highest sublot percent passing and the lowest sublot percent passing each required sieve in one lot.

190 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.

200 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%.

A Type C certification in accordance with 916 shall be provided for the stabilizing additives for each shipment. 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 sublot, all test results of the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

210 Samples shall not be obtained from areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3. If a random location falls within this area, the Engineer will randomly select another location within the sublot for sampling. If an entire sublot falls within this area, test results from the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

CONSTRUCTION REQUIREMENTS

220 **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.

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

230 SMA mixtures shall not exhibit segregation, flushing, or bleeding. Corrective action shall immediately be taken to prevent continuation of these conditions. Segregated, flushed, or bleeding of SMA mixtures will be referred to the Department's

Division of Materials and Tests for adjudication as a failed material in accordance with 105.03.

All mixtures that become loose and broken, mixed with dirt, or are in any way defective shall be removed and replaced in accordance with 105.03.

410.11 Preparation of Surfaces to be Overlaid

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.

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.

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. The temperature of mixture at the time of spreading shall be no more than 315°F whenever PG 70-22 binder is used or no more than 325°F whenever PG 76-22 binder is used. The temperature of each mixture shall not be less than 245°F at the time of spreading when placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3. No mixture shall be placed on a previously paved course that has not cooled to less than 175°F.

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.

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.

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, 409.03(d)2, or 409.03(d)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. Oscillatory rollers in accordance with 409.03(d)5 will be allowed for use but the vertical impact force capability shall not be used, except the vertical impact force capability 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 five 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.

410.15 Joints

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

Hot poured joint adhesive in accordance with 906 shall be applied to longitudinal joints constructed between two adjacent HMA courses in the top course of dense graded intermediate mixtures and all 9.5 mm and 12.5 mm SMA mixture courses. This includes joints within the traveled way as well as between any of the following:

(a) traveled way and an auxiliary lane,
(b) traveled way and a paved shoulder, and
(c) auxiliary lane and a paved shoulder.

The material shall be heated in a jacketed, double boiler melting kettle. The kettle shall have an attached pressure feed wand system with applicator shoe.

The joint adhesive shall be applied to the face of the previously constructed edge at the joint using a wand applicator. Prior to application of the joint adhesive, the joint face shall be dry and free of loose material and foreign objects. The adhesive shall be applied on the joint face 1/8 in. thick at the temperature recommended by the manufacturer. Excess joint adhesive shall not be allowed to pool on the top of the previously constructed pavement course or the pavement to be overlaid. The application of the adhesive shall be made within the same day, but at least 30 minutes prior to construction of the longitudinal joint.

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.

410.16 Density

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

The Engineer's acceptance test results for each sublot will be available after the sublot 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 sublot 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.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6.00 ±0.25 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.

Cores shall not be obtained from areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3. If a random location falls within this area, the Engineer will randomly select another location within the sublot for coring. If an entire sublot falls within this area, test results from the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific sublot 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.

The density of the mixture will be expressed as:

$$\text{Density, \%} = \frac{\text{BSG}}{\text{MSG}} \times 100$$

where:

BSG = average bulk specific gravity
MSG = maximum specific gravity

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 331, 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 sublot 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 either SMA of similar or smaller size particles or bridge deck repair material from the QPL of Rapid Setting Patch Materials. The rapid setting patch material shall be mixed in a separate container and placed in the hole in accordance with the manufacturer's recommendations, consolidated by rodding, and struck-off flush with the adjacent pavement. The Contractor's plan for refilling core holes shall be outlined in the QCP.

410.17 Pavement Corrugations

Pavement 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 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

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
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 Division of Materials and Tests. 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 Division of Materials and Tests.

(a) Mixture

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							
	25.0 mm	19.0 mm	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	0.1	0.1	0.2	0.3
For each 0.1% above 1.0% out of tolerance	0.1	0.1	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.

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)
No. 8 (2.36 mm)	0.1
No. 30 (600 µm)	0.1
No. 200 (75 µm)	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:

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.

(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, %
> 97.0	Submitted to the Division of Materials and Tests*
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
≤ 89.0	Submitted to the Division of Materials and Tests*
* 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 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 sublot. The sublot and specific tests shall be specified at the time of the appeal request. Only one appeal request per sublot is allowed. Once the appeal request has been granted, 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 331, 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.

Joint adhesive will be measured by the linear foot in accordance with 109.01(a).

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, operating the inertial profiler, and furnishing IRI profile information will be made in accordance with 401.18.

Furnishing and operating the 16 ft straightedge shall be included in the cost of other pay items within this section.

Joint adhesive will be paid for by the linear foot, complete in place.

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 will be prepared to reflect contract adjustments in accordance with 109.05.

Payment will be made under:

Pay Item	Pay Unit Symbol
Joint Adhesive, _____ (course type)	LFT
QC/QA - HMA, _____, _____, _____, _____ mm, - SMA (ESAL[1])(PG[2])(Course[3])(Mix[4])	TON
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 or Intermediate
[4] Mixture Designation

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.

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 inertial profiler, HMA will be full compensation regardless of how often the inertial profiler is used or how often the IRI is determined.

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.

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

MATERIALS

411.02 Materials
Materials shall be in accordance with the following:

Asphalt Emulsion ..... 902.01(b)1
Coarse Aggregates – Class B or Higher* 904.03
Fine Aggregates** 904.02
Portland Cement, Type I ..... 901.01(b)
Water 913.01

* The coarse aggregate angularity shall be a minimum of 95% in accordance with ASTM D5821. 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:

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 DMF for the specific materials to be used on the project to the DTE 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:

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:

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%
Compatibility Classification	TB-144	11 pts min.
Wet Track Abrasion Loss 60 minutes soak, max. 6 day soak, max.	TB-100	 538 g/sq m 807 g/sq m
Mix Time @ 77°F (25°C)	TB-113**	controllable to 120 s
Mix Time @ 104°F (40°C)	TB-113**	controllable to 35 s
Excess Binder	TB-109	538 g/sq m
Deformation, max.	TB-147	5%

* 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.

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) DMF/JMF
(e) inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
(f) QCP in accordance with ITM 803.

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.

Any existing durable pavement markings shall be removed in accordance with 808.10 prior to placement of warranted micro-surfacing.

Cracks in the pavement in excess of 1/4 in. shall be filled in accordance with 408 prior to placement of warranted micro-surfacing.

The pavement surface shall have tack coat applied in accordance with 406 prior to placement of warranted micro-surfacing.

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 micro-surface shall be cured a minimum of five days prior to applying permanent pavement markings in accordance with 808.

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 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.

The Contractor shall furnish a warranty bond at the pre-construction 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.

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.

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.

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.

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 or remedial work to be performed and all 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 performed 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 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.

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:

(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 E274 and ASTM E524.

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 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.

If the Department determines that any distress 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 at 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.

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

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 will perform no routine pavement surface maintenance activities during the warranty period.

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

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:

Pay Item	Pay Unit Symbol
Micro-Surfacing, Warranted, for Approaches, Multiple Course	SYS
Micro-Surfacing, Warranted, for Approaches, Single Course	SYS
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

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

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.

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 lanes 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.

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 to ensure even and uniform coverage to the pavement surface.

412.07 Protection of Surface

Fine aggregate or other approved blotting material shall be applied to pedestrian crosswalks, driveways, or other areas as directed. 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

The fog seal shall be cured a minimum of five 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:

Pay Item	Pay Unit Symbol
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.

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:

Asphalt Emulsion ..... 902.01(b)2
Asphalt Materials
PG Binder, PG 64-22, PG 76-22 ..... 902.01(a)
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) Blank

(b) Asphalt Materials

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

PG Binder	ESAL
64-22	< 10,000,000
76-22	≥ 10,000,000

Additional requirements for the PG 76-22 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

Additional requirements for coarse aggregate shall also be as follows:

Characteristic	Method	Min.	Max.
Coarse Aggregate Angularity	ASTM D5821	95/85*	
Micro-Deval Abrasion, % loss	AASHTO T 327		18
* Denotes two faced crush requirements.			

414.03 Design Mix Formula

The DMF shall be determined for each mixture prepared by a Qualified Mix Design Laboratory selected from the Department's list of Qualified Mix Design Laboratories. The Contractor shall submit a DMF for each mixture to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture, the

mixture gradation, the total aggregate bulk specific gravity, the maximum and bulk specific gravity of the UBWC mixture and the application rate for any anti-stripping additives. No mixture shall be used until the DMF has been reviewed by the DTE.

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)			
Sieve Size	**12.5 mm**	**9.5 mm**	**4.75 mm**
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.

The maximum specific gravity of the UBWC mixture shall be mass determined in water in accordance with AASHTO T 209.

The bulk specific gravity of the UBWC mixture shall be determined in accordance with AASHTO T 331.

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

The 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 3/4 ±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 ±10°F.

(1) AASHTO T 283 shall be used with the following exceptions:

(a) Condition the mixture for 4 h in accordance with AASHTO R 30, Section 7.1.

(b) Compact the Superpave Gyratory 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 lb/sq in.

414.05 Use of Recycled Materials

Recycled materials shall be in accordance with 401.06 for dense graded surfaces, except RAP for use in the UBWC mixture shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

414.06 Quality Control

The Contractor shall produce a mixture in compliance with the DMF 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.

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 ±0.5% from that stated in the DMF 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 DMF as tested in accordance with AASHTO T 30.

Sieve Size	Quality Control Tolerances (±), % 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 µm)	1.0	1.0	1.0

CONSTRUCTION REQUIREMENTS

414.07 Equipment

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

The paver shall be self-priming, designed and built for applying the UBWC. The paver shall have:

(a) a receiving hopper,
(b) feed system,
(c) asphalt emulsion storage tank,
(d) a calibrated metering system for measuring the emulsion volume applied,
(e) a spray bar,
(f) a heated, variable width, combination vibratory screed, or
(g) 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.

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.

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.

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:

(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) JMF
(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.

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

Pavement smoothness shall be controlled by the Contractor with a 16 ft straightedge longitudinally and will be controlled by the Department with a 10 ft straightedge transversely. The 16 ft straightedge shall be in accordance with 306.03(d). The 10 ft straightedge will be in accordance with 306.03(d). Smoothness correction shall be in accordance with 401.18(e).

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.

The Contractor shall furnish to the Engineer a warranty bond at the pre-construction 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.

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.

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.

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.

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.

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.

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

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 E274 and ASTM E524.

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.

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.

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

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 will perform no routine pavement surface maintenance activities during the warranty period.

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

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:

Pay Item	Pay Unit Symbol
Ultrathin Bonded Wearing Course for Approaches, _____ size	..... SYS
Ultrathin Bonded Wearing Course, _____ size	..... SYS

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.

SECTION 415 – BLANK

SECTION 416 - COLD IN-PLACE RECYCLING, CIR

416.01 Description

This work shall consist of milling and pulverizing a portion of the existing asphalt pavement to specified depth and maximum size, mixing asphalt emulsion, water and additives to produce a recycled asphalt layer. This material shall then be placed and compacted to the approved design properties in accordance with 105.03.

416.02 Just-in-Time Training, JITT

The Engineer and the Contractor are required to attend a JITT course regarding CIR and both shall mutually agree on the course instructor, course content and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for CIR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of CIR operations.

The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with asphalt emulsion stabilized CIR.

A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.

416.03 Quality Control

A QCP shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. The QCP shall include the proposed CIR mix design, a start to finish process description to include discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, and the curing methods applied to the CIR. All QC test results and responses to test results shall be maintained during the duration of the contract and made available to the Engineer upon request.

The following table provides the type and minimum frequency for tests.

QC TESTING	
Test	Frequency[1,2]
Depth of Pulverization	1 per 500 ft
Pulverized Material Gradation	1 per 0.5 day of processing
Asphalt Emulsion Content	1 per 500 ft
Water Content	1 per 500 ft
Compacted In-Place Field Density	1 per 1,000 ft
Field Moisture Content for Curing	1 per each day of production
Optimum Field Density	1 per 2 days of production

1. The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design.
2. Testing frequency is based upon linear feet of CIR processing.

MATERIALS

416.04 Materials

CIR shall consist of a homogenous blend of RAP combined with asphalt emulsion, water, and when required, recycling additives such as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized CIR may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the CIR mix design and project requirements.

Materials for use in CIR shall be in accordance with the following:

Asphalt Emulsion ..... 902.01(b)3
Corrective aggregate to adjust gradation or supplement material volume:
1. Coarse or Dense Graded Aggregate, Class C or Higher 904.03

2. Fine Aggregate 904.02
3. RAP shall be the product resulting from the cold milling or crushing of an existing asphalt pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.

Portland Cement, Type I ..... 901.01(b)
Water 913.01

A Type D certification in accordance with 916 and the Frequency Manual shall be provided for the CIR.

416.05 Mix Design

The CIR mix design shall be in accordance with ITM 592 and shall be comprised of existing RAP, asphalt emulsion, and if necessary, recycling additives. The mix design and all associated testing shall be performed, using samples of the existing pavement material from the project site representing the recycling depth, by a design laboratory that is AASHTO re:source accredited in HMA and asphalt emulsion. Additional mix designs shall be developed when the in-place material changes significantly to establish representative mixes for the entire job. The Contractor shall be responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned CIR shall be the minimum sampling frequency for mix design preparation.

The mix design, or designs, shall be submitted to the Engineer for approval at least five calendar days prior to the JITT and shall include results of all tests performed. If new materials are added, a new mix design shall be submitted at least one day prior to implementation. New mix designs shall include the updated test results.

CONSTRUCTION REQUIREMENTS

416.06 Roadway Preparation

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to CIR operations.

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized material during milling operation.

Grade adjustments of existing structures shall be made in accordance with 720.04 prior to CIR operations, except existing structures shall be lowered, properly covered, and filled with material compatible with the CIR mix design to maintain traffic.

All areas of soft or yielding subgrade, as shown on the plans, shall be corrected prior to CIR operations.

416.07 Equipment

The recycling equipment shall be capable of milling the existing asphalt pavement, sizing the resulting RAP, and mixing the RAP with the materials stipulated in the mix design. The recycling equipment shall be capable of meeting the specified sizing requirement with either the milling process or with additional sizing equipment. The recycling equipment shall be capable of producing a homogenous and uniformly coated CIR mixture by mixing the RAP with the asphalt emulsion, water and any other additives, either in the cold planer housing or in an additional mixing chamber. The equipment used for placement of the CIR mixture shall be capable of the placement in accordance with 105.03.

The CIR equipment shall consist of the following major components:

(a) Cold In-Place Recycler Equipment

The cold in-place recycling equipment will include either a single unit recycler or a multi-unit recycler.

1. Single Unit Recycler

The single-unit recycler shall be a self-propelled cold milling/cold recycling machine with a down cutting cutter head capable of pulverizing and recycling the existing HMA pavement to the depth specified, incorporate the asphalt emulsion and water, and combine the materials to produce a homogenous mixture. The machine shall have two systems for adding asphalt emulsion and water. Each system having a full width spray bar with a positive displacement pump interlocked to the machine's ground speed to ensure that the amount of asphalt emulsion and water being added is automatically adjusted with changes to the machine's ground speed. Each additive system shall have its own spray bar equipped with two nozzles per foot of spray bar and be capable of incorporating up to 7 gal./sq yd of asphalt emulsion or water. Individual valves on the spray bar shall be capable of being turned off as necessary to minimize asphalt emulsion and water overlap on subsequent passes.

2. Multi-Unit Recycler

A multi-unit recycler may be utilized instead of a single unit recycler. The multi-unit recycler shall contain the following:

a. A self-propelled cold milling machine capable of pulverizing the existing asphalt material in a single pass to the depth shown on the plans and to a minimum width of not less than 12 1/2 ft. The machine shall have automatic depth controls to maintain the cutting depth to within ±1/4 in. of that shown on the plans and shall have a positive means for controlling cross slope elevations. The use of a heating device to soften the pavement will not be allowed.

b. A material-sizing unit having screening and crushing capabilities to reduce the cold pulverized material to the appropriate size. The screening and crushing unit shall have a closed-circuit system capable of continuously returning oversized material to the crusher. All pulverized material shall be processed to the maximum size requirements specified.

c. A mixing unit equipped with a belt scale for the continuous weighing of the pulverized and sized asphalt material and a coupled/interlocked computer controlled liquid metering device. The mixing unit shall be an on-board completely self-contained pugmill. The liquid metering device shall deliver the amount of asphalt emulsion to within ±0.25% of the required amount by weight of the pulverized asphalt material. The asphalt emulsion pump shall be of sufficient capacity to allow emulsion contents up to 4.0% by weight of pulverized material. Also, automatic digital readings shall be displayed for both the flow rate and total amount of pulverized asphalt material and asphalt emulsion in appropriate units of weight and time.

(b) Spreaders for Dry Cement

Spreaders used to apply dry cement recycling additives shall be non-pressurized mechanical vane-feed, cyclone or screw type capable of providing a consistent, accurate and uniform distribution of material while minimizing dust during construction.

(c) Additive Slurry Storage and Supply Equipment

Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water, and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

(d) Spreading of Corrective Aggregate

Corrective aggregate, when required, shall be placed with a mechanical spreader or a conventional paver.

(e) Water Truck

A water truck for supplying water to the milling equipment during CIR operation shall be provided. The water truck system shall be able to supply the mixing chamber, if necessary, to provide an independent source of water to properly disperse the asphalt emulsion.

(f) Laydown Equipment

The processed CIR mixture shall be spread uniformly across the recycling width using either a self-propelled paver in accordance with 409.03(c) or screed integral to the recycling equipment.

The screed shall be controlled by electronic grade and cross slope control. The equipment shall be of sufficient size and power to spread the recycled material in one continuous pass, without segregation, in accordance with 105.03. Heating of the screed will not be allowed.

In utilizing a self-propelled paver, material shall either be loaded directly into the paver hopper from the recycling equipment or loaded by a pickup device from a windrow.

If utilizing a pickup device, it shall be capable of removing and transferring the entire windrow of recycled mix in a single pass. The pick-up machine shall be within 150 ft of the mixing unit throughout the treatment process.

(g) Compaction Equipment

Compaction equipment shall be in accordance with 409.03(d). The number, weight, and types of rollers shall be as necessary to obtain required compaction. At a minimum, the following rollers shall be used:

1. At least one pneumatic tired roller in accordance with 409.03(d)3 with a minimum weight of not less than 20 t.

2. At least one double drum vibratory roller in accordance with 409.03(d)4 with a minimum weight of not less than 10 t.

416.08 Weather Limitations

CIR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50ºF with ambient temperatures above 35ºF for seven days. The Engineer may restrict work when the heat index is greater than 100°F. The CIR shall not be performed before May 1 or after October 1.

416.09 Processing and Mixing Operation

For CIR mixtures, the pulverization shall produce a gradation that has 100% passing the 1 1/2 in. (37.5 mm) sieve.

Corrective aggregate, when required, shall be spread onto the existing surface using a mechanical spreader or a conventional paver.

An additive used in asphalt emulsion stabilized CIR may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.

The pulverized material shall be processed through a mixing unit capable of combining the pulverized material, asphalt emulsion, and any additives to produce a homogenous recycled mixture. The asphalt emulsion shall be injected into the pulverized asphalt material at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.

When a paving fabric is encountered during the pulverization operation, the Contractor shall make necessary changes in equipment or operations so incorporation of shredded fabric into the CIR does not affect the performance parameters or inhibit placement or compaction of the CIR. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed, as observed, from the roadway during the CIR process. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

Any such materials retained in the mixture shall be appropriately sized and blended so as to not adversely affect the strength of the CIR.

Asphalt emulsion shall have an application tolerance determined by adding ±0.25% to the percent total asphalt emulsion content recommended by the mix design.

The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

416.10 Control Strip and Compaction

A minimum 500 ft long control strip shall be conducted on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

(a) demonstrate the proposed equipment, materials, and processes can produce a CIR layer in accordance with specification requirements,

(b) determine the optimal rates for the asphalt emulsion, water, and any additives recommended for the reclaimed material, and

(c) determine the sequence and manner of rolling necessary to obtain specified density requirements.

The CIR density shall be achieved with the same equipment, materials, construction methods, and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside of the tolerances of the original mix design, equipment, or construction methods.

A rolling pattern that produces the maximum obtainable density, or optimum field density, shall be determined during the control strip using a roller in accordance with 409.03(d)4. The Contractor shall provide a sequence and manner of rolling by establishing a roller pass versus density chart showing the progress of densification from initial lay down through optimum field density using a properly calibrated nuclear gauge in accordance with AASHTO T 310. Production may continue after approval of the control strip.

The Contractor shall perform compaction testing in accordance with AASHTO T 310 during production to ensure compaction is between 97% and 102% of the optimum field density established during the control strip. If two successive tests indicate compaction is over 102% or below 97% of the optimum field density, a new rolling pattern and roller pass versus density chart shall be established.

The QC technician shall be on site, observing all compaction efforts, and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.

Any type of rolling effort that causes cracking, displacement, or other type of pavement distress shall be discontinued until such time as the problem can be resolved as approved by the Engineer.

Rollers shall not be started or stopped on recycled material except when changing direction during the compaction process.

All tests shall be conducted at the stated QC testing frequencies throughout CIR operations.

416.11 Opening to Traffic

Opening to traffic shall occur after sufficient cure time has been applied to the CIR so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.

416.12 Maintenance

The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the surface course has been constructed.

Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or CIR material as directed by the Engineer. No direct payment will be made for damage or repair unless approved by the Engineer.

416.13 Curing

Before placing the final surfacing, the recycled surface shall remain in-place for a minimum of three days and meet one of the following conditions:

(a) there is less than 3.0% moisture remaining in the mixture, or

(b) the material has cured for a minimum of 10 consecutive days without rainfall.

The planned method and duration of curing for CIR shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the CIR final cure, but no later than November 1.

416.14 Milling

The entire surface of the CIR shall be scarified in accordance with 306.04 in preparation for the overlay, except liquidated damages will not apply. Construction engineering shall be provided in accordance with 105.08(b).

416.15 CIR Surface Course

The surface course atop the CIR shall be as shown on the plans.

The CIR shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the surface. The CIR shall be swept lightly to avoid damage to the CIR.

A tack coat shall be required only for the HMA overlay and shall be applied to the CIR in accordance with 406 immediately following sweeping operations.

Monuments shall be reestablished in accordance with 615.10.

416.16 Method of Measurement

The CIR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the ton. Aggregate used to adjust the CIR gradation will be measured by the ton. HMA patching will be measured in accordance with 304.06. Milling will be measured in accordance with 306.10. Re-established monuments will be measured in accordance with 615.13. Grade adjustment of existing structures will be measured in accordance with 720.06. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12. Portland cement will be measured by the ton.

416.17 Basis of Payment

The CIR will be paid for at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per ton, complete in place. Aggregate used to adjust the CIR gradation will be paid for at the contract unit price per ton, complete in place. HMA patching will be paid for in accordance with 304.07 for the thickness shown on the plans. Milling will be paid for in accordance with 306.11. Re-established monuments will be paid for in accordance with 615.14. Grade adjustment of existing structures will be paid for in accordance with 720.07. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

Portland cement will be paid for in accordance with 104.03. The change order will include direct material costs, delivery costs, and shall not include any other markups.

Payment will be made under:

Pay Item	Pay Unit Symbol
Cold In-Place Recycling	SYS
Corrective Aggregate, CIR	TON
Stabilizing Material, Asphalt Emulsion	TON
Stabilizing Material, Portland Cement	TON

The costs of the CIR mix design and QC testing shall be included in the cost of the CIR.

The costs associated with removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the CIR.

The costs associated with stabilizing, compacting, curing and maintenance of the CIR not related to failing subgrade shall be included in the cost of the CIR.

The cost associated with mixing water shall be included in the cost of the CIR.

The cost associated with aggregate when used to supplement material volume shall be included in the cost of the corrective aggregate pay item.

When portland cement is a required stabilizing material, costs associated with mixing, installation, compaction, curing, and maintenance shall be included in the cost of the CIR.

The cost associated with aggregate when used to adjust the CIR gradation shall be included in the cost of the corrective aggregate pay item.

The cost of milling the asphalt emulsion stabilized CIR to maintain profile shall be included in the cost of the milling.

In the locations of failing subgrade, removal of the CIR shall be included in the cost of subgrade treatment.

SECTION 417 - COLD CENTRAL PLANT RECYCLING, CCPR

417.01 Description

This work shall consist of a mixture of sized RAP millings from existing asphalt pavement or existing stockpiles, asphalt emulsion, water, and other additives. The mixture shall be produced at a nearby location, then placed and compacted to produce a recycled asphalt layer to the approved design properties in accordance with 105.03.

417.02 Just-in-Time Training

The Engineer and the Contractor are required to attend a JITT course regarding CCPR and both shall mutually agree on the course instructor, course content, and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for CCPR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of CCPR operations.

The Contractor shall provide a JITT instructor experienced in the construction methods, materials, and test methods associated with asphalt emulsion stabilized CCPR. A copy of the course syllabus, handouts, and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.

417.03 Quality Control

A QCP shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. The QCP shall include the proposed CCPR mix design, a start to finish process description to include discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, and the curing methods and procedures applied to the CCPR.

All QC test results and response to test results shall be maintained during the duration of the contract and made available to the Engineer upon request.

The following table provides the type and minimum frequency for tests:

QC TESTING	
Test	Frequency[1,2]
Depth of Laydown	1 per 500 ft
Pulverized Material Gradation	1 per 1,000 tons of production
Pulverized Material Moisture Content	1 per 500 tons of production
Asphalt Emulsion Content[3]	1 per 500 tons of production
Water Content[3]	1 per 500 tons of production
Compacted In-Place Field Density	1 per 1,000 ft
Field Moisture Content for Curing	1 per each day of production
Optimum Field Density	1 per 2 days of production

1. The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design.
2. Testing frequency is based upon either linear feet of CCPR laydown or tons of CCPR mixture processing.
3. Asphalt emulsion content and water content shall be taken from the readings of the control settings of the mixing unit.

MATERIALS

417.04 Materials

CCPR shall consist of a homogenous blend of RAP combined with asphalt emulsion, water, and when required, recycling additives such as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized CCPR may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the CCPR mix design and project requirements.

Materials for use in CCPR shall be in accordance with the following:

Asphalt Emulsion ..... 902.01(b)3
Corrective Aggregate to adjust gradation or supplement material volume:

1. Coarse or Dense Graded Aggregate, Class C or Higher 904.03
2. Fine Aggregate 904.02
3. RAP shall be the product resulting from the cold milling or crushing of existing asphalt pavement and processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.

Portland Cement, Type I ..... 901.01(b)
Water 913.01

A Type D certification in accordance with 916 and the Frequency Manual shall be provided for the CCPR.

417.05 Mix Design

CCPR mix designs shall be in accordance with ITM 592 and shall be comprised of existing RAP, asphalt emulsion, and recycling additives, if necessary. The mix design and all associated testing shall be performed using samples of each proposed material. RAP samples shall either be collected from the existing pavement at the project site representing the milling depth or from the RAP stockpile to be used during construction. The mix design shall be completed by a design laboratory that is AASHTO re:source accredited in HMA and asphalt emulsion. Additional mix designs shall be developed when the proposed material changes significantly to establish representative mixes for the entire job. The Contractor shall be responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned CCPR shall be the minimum sampling frequency for mix design preparation.

The mix design, or designs, shall be submitted to the Engineer for approval at least five calendar days prior to the JITT and shall include results of all tests performed. If new materials are added, a new mix design, including the updated test results, shall be submitted at least one day prior to implementation.

CONSTRUCTION REQUIREMENTS

417.06 Roadway Preparation

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to CCPR operations.

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized asphalt material during milling operation.

All areas of soft or yielding subgrade shall be corrected prior to CCPR operations.

If the CCPR mix is to be placed on a prepared subgrade or aggregate base, the Contractor shall ensure the subgrade soils and base have been properly prepared, moisture treated, and compacted to the minimum density as specified, immediately prior to placement of the CCPR mix to create an evenly graded, unyielding surface.

417.07 Pavement Removal

The existing asphalt pavement shall be milled in accordance with 306 to the length, depth, and width as specified. The RAP shall be free of contamination of dirt, base, concrete or other deleterious materials such as silt and clay.

When paving fabric is encountered during the pulverization operation, the Contractor shall make necessary changes in equipment or operations so incorporation of shredded fabric into the CCPR does not affect the performance parameters or inhibit placement or compaction of the CCPR. The Contractor shall remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled

material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed as observed from the roadway. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

Any such materials retained in the mix shall be appropriately sized and blended so as not to adversely affect the strength of the recycled pavement.

417.08 Equipment

The equipment shall consist of the following major components:

(a) Milling Machine/Pavement Cold Planer

Milling equipment shall be in accordance with 306.03(a). The equipment shall be capable of pulverizing the existing asphalt material in a single pass to the depth shown on the plans. The machine shall have automatic depth controls to maintain the cutting depth to within ±1/4 in. of that shown on the plans. The milling operation shall not disturb or damage the underlying material. The use of a heating device to soften the pavement will not be allowed.

(b) Additive Slurry Storage and Supply Equipment

Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

(c) Sizing Equipment

A material-sizing unit shall be capable of sizing using a scalping screen or crushing capabilities to reduce RAP to a maximum size of 1 1/2 in. (37.5 mm) or to the maximum size requirements specified prior to mixing with the asphalt emulsion.

(d) Mixing and Proportioning Equipment

The equipment shall be capable of processing sized RAP, asphalt emulsion, water, and any additives stipulated in the mix design into a homogenous and uniformly coated CCPR mixture. The CCPR 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. The equipment shall display automatic digital readings for the flow rate of both the RAP and asphalt emulsion in appropriate units of weight and time.

The mixing apparatus shall have cold feed hopper equipped with vibrators on the

hopper walls to assist the free flow of materials to a variable speed belt conveyor. Control of the RAP shall be by mechanically adjustable gate valves at the point of discharge or a RAP belt scale for the continuous weighing of the RAP. The variable speed belt conveyor or RAP belt scale shall be interlocked to the asphalt emulsion metering device.

The asphalt emulsion metering device shall be capable of automatically adjusting the flow of asphalt emulsion to compensate for any variation in the amount of RAP introduced into the mixing apparatus. Asphalt emulsion shall be metered by weight of RAP using a calibrated meter that will accurately measure the amount of asphalt emulsion to within a tolerance of ±2.0% of the specified rate.

(e) Hauling Equipment

Hauling equipment shall be in accordance with 409.03(b).

(f) Laydown Equipment

Laydown equipment shall be in accordance with 409.03(c).

The paver screed shall be controlled by electronic grade and cross slope control. Heating of the screed shall not be allowed.

CCPR material shall either be loaded directly into the paver hopper from transport trucks or loaded by a pickup device. If utilizing a pickup device, it shall be capable of removing and transferring the entire windrow of recycled mix in a single pass.

The equipment used for placement of the CCPR mixture shall be capable of the placement in accordance with 105.03.

(g) Compaction Equipment

Compaction equipment shall be in accordance with 409.03(d). The number, weight, and types of rollers shall be as necessary to obtain required compaction. At a minimum, the following rollers shall be used:

1. At least one pneumatic tired roller in accordance with 409.03(d)3 with a minimum weight of not less than 20 t.

2. At least one double drum vibratory roller in accordance with 409.03(d)4 with a minimum weight of not less than 10 t.

417.09 Weather Limitations

CCPR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50ºF with ambient temperatures above 35ºF for seven days. The Engineer may restrict work when the heat index is greater than 100°F. The CCPR shall not be performed before May 1 or after October 1.

417.10 Material Sizing and Stockpiling

The gradation of the RAP shall have 100% passing the 1 1/2 in. (37.5 mm) sieve, or be sized to meet specific contract requirements.

RAP that has been crushed and screened shall be stockpiled and maintained to prevent reconsolidation. Water may be added to RAP as it is screened and crushed to abate dust and mitigate reconsolidation.

Corrective aggregate, if required, shall either be mixed with RAP to produce a homogenous mixture during stockpiling or fed into the mixing apparatus at the rate determined by the mix design.

417.11 Processing and Mixing Operation

The sized RAP shall be processed through a mixing unit capable of combining the sized RAP, asphalt emulsion, and any additives to produce a homogenous recycled mixture.

An additive used in asphalt emulsion stabilized CCPR may be dry powder or slurry. The Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.

The asphalt emulsion shall be injected into the CCPR materials at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.

The asphalt emulsion shall have an application tolerance determined by adding ±0.25% to the percent total asphalt emulsion content.

The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

417.12 Placement

The depth of CCPR shall be as indicated on the plans.

The hauling equipment shall deliver the blended CCPR material into the paver within one hour of mixing or before the asphalt emulsion begins to break and set.

CCPR single lift thickness shall be a minimum compacted depth of 3 in. and shall not exceed a maximum compacted depth of 5.5 in. Tack coat in accordance with 406 shall be applied between the lifts.

417.13 Control Strip and Compaction

A minimum 500 ft long control strip shall be conducted on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

(a) demonstrate the equipment, materials, and processes proposed to produce a CCPR layer in accordance with specification requirements,

(b) determine the optimal rates for the asphalt emulsion, water and any additives recommended for the material, and

(c) determine the sequence and manner of rolling necessary to obtain specified density requirements in one uniformly compacted layer.

The CCPR density shall be achieved with the same equipment, materials, construction methods, and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside of the tolerances of the original mix design, equipment, or construction methods.

A rolling pattern that produces the maximum obtainable density, or optimum field density, shall be determined during the control strip using a roller in accordance with 409.03(d)4. The Contractor shall provide a sequence and manner of rolling by establishing a roller pass versus density chart that shows the progress of densification from initial lay down through optimum field density using a properly calibrated nuclear gauge in accordance with AASHTO T 310. Production may continue after approval of the control strip.

The Contractor shall perform compaction testing in accordance with AASHTO T 310 during production to ensure compaction is between 97% and 102% of the optimum field density established during the control strip. If two successive tests indicate compaction is over 102% or below 97% of the optimum field density, a new rolling pattern and roller pass versus density chart shall be established.

The QC technician shall be on site, observing all compaction efforts, and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.

Any type of rolling effort that causes cracking, displacement, or other type of pavement distress shall be discontinued until such time as the problem can be resolved as approved by the Engineer.

Rollers shall not be started or stopped on recycled material unless when changing direction during the compaction process.

All tests shall be conducted at the stated QC testing frequencies throughout CCPR operations.

417.14 Opening to Traffic

Opening to traffic shall occur after sufficient cure time has been applied to the CCPR so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.

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417.15 Maintenance

The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the surface course has been constructed.

Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or CCPR material as directed by the Engineer. No direct payment will be made for damage repair unless approved by the Engineer.

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417.16 Curing

Before placing the final surfacing, the recycled surface shall remain in-place for a minimum of three days and meet one of the following conditions:

(a) there is less than 3.0% moisture remaining in the mixture, or

(b) the material has cured for a minimum of 10 consecutive days without rainfall.

320 The planned method and duration of curing for CCPR shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the CCPR final cure, but no later than November 1.

417.17 Milling and Pavement Smoothness

When the CCPR material is placed in a single lift, the entire surface of the CCPR shall be scarified in accordance with 306.04 in preparation for the overlay, except liquidated damages will not apply. Construction engineering in accordance with 105.08(b) shall be provided.

330 Pavement smoothness of the cured CCPR mat shall meet the requirements of 401.18(b) The Contractor shall correct humps or depressions exceeding the tolerances in accordance with 401.18(c).

417.18 CCPR Surface Course

The CCPR shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the tack coat. A tack coat shall be required and shall be applied to the CCPR in accordance with 406.

Monuments shall be reestablished in accordance with 615.10 after the surface course is placed.

417.19 Method of Measurement

The CCPR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the ton. Aggregate used to adjust the CCPR gradation will be measured by the ton. HMA Patching will be measured in accordance with 304.06. Re-established monuments will be measured in accordance with 615.13. Grade adjustment of existing structures will be measured in accordance with 720.06. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12. Portland cement will be measured by the ton.

417.20 Basis of Payment

The CCPR will be paid for at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per ton, complete in place. Aggregate used to adjust the CCPR gradation will be paid for at the contract unit price per ton, complete in place. HMA patching will be paid for in accordance with 304.07 for the thickness shown on the plans. Re-established monuments will be paid for in accordance with 615.14. Grade adjustment of existing structures will be paid for in accordance with 720.07. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

Portland cement will be paid for in accordance with 104.03. The change order will include direct material costs, delivery costs, and shall not include any other markups.

Payment will be made under:

Pay Item	Pay Unit Symbol
Cold Central Plant Recycling	SYS
Corrective Aggregate, CCPR	TON
Stabilizing Material, Asphalt Emulsion	TON
Stabilizing Material, Portland Cement	TON

The costs associated with the CCPR mix design and quality control testing shall be included in the cost of the cold central plant recycling.

The costs associated with the removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the CCPR.

The costs associated with pulverizing, stabilizing, compacting, curing and maintenance of the CCPR not related to failing subgrade shall be included in the cost of the CCPR.

The cost associated with mixing water for cold central plant material shall be included in the cost of the cold central plant recycling.

The cost associated with aggregate used to supplement material volume shall be included in the cost of the corrective aggregate pay item.

When portland cement is a required stabilizing material, costs associated with mixing, installation, compaction, curing, and maintenance shall be included in the cost of the CCPR.

The cost associated with aggregate used to adjust the CCPR gradation shall be included in the cost of the corrective aggregate pay item.

The costs of the asphalt emulsion stabilizing material shall be included in the cost of the stabilizing material pay item.

In the locations of failing subgrade, removal of the CCPR shall be included in the cost of subgrade treatment.