TN TDOT Department of Transportation

STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

January 1, 2021

TENNESSEE DEPARTMENT OF TRANSPORTATION

STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

Tennessee Department of Transportation, Authorization No. 401093, 5,000 copies, January 2021. This public document was promulgated at a cost of $5.83 per copy.

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TENNESSEE DEPARTMENT OF TRANSPORTATION

The mission of the Tennessee Department of Transportation is to provide a safe and reliable transportation system that supports economic growth and quality of life.

SECTION 307 – BITUMINOUS PLANT MIX BASE (HOT MIX)

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DESCRIPTION

307.01 Description

This work consists of constructing one or more base course layers of aggregate and asphalt, prepared in a hot bituminous mixing plant and spread and compacted on a prepared subgrade, granular sub-base, or base.

MATERIALS

307.02 Materials

Provide materials as specified in:

Aggregate for Mixture,
Grading A, ACRL, AS, B, BM, BM2, C, CS, or CW..... **903.06**
Asphalt Cement, Grade PG 64-22, 70-22, 76-22, 82-22..... **904.01**
Bituminous Additives **921.06.B**

The specific grading of aggregate to be used will be specified in the Contract or shown on the Plans. The Engineer will accept mineral aggregate, bituminous material, and the plant mix in accordance with **407.02**.

307.03 Composition of Mixtures

A. General

The bituminous base and/or leveling course shall be composed of aggregate and bituminous materials. The hot plant mixes shall comply with the applicable requirements of **407.03**.

Combine the specified mineral aggregate and asphalt cement in proportions that will meet the design composition limits specified in Table 307.03-1.

Table 307.03-1: Mixture Composition

Mixtures	Proportions of Total Mixture, Percent by Weight	
	Combined Mineral Aggregate, %	Asphalt Cement, % [1]
Grading AS and ACRL	96.3 - 97.7	2.3 - 3.7
Grading A	95.8 - 96.7	3.3 - 4.2
Grading B, BM, and BM2	93.8 - 95.8	4.2 - 6.2
Grading C and CW	93.8 - 95.8	4.2 - 6.2
Grading CS	92.3 - 94.7	5.3 - 7.7

[1] If the effective combined specific gravity of the aggregate exceeds 2.80, the Engineer may adjust the proportions specified.

In addition, combine the materials with the required amount of bitumen to meet the design properties specified in Table 307.03-2, except that on low volume roads (ADT 1,000 or below), the minimum stability shall be 1,500 pound-feet and the VMA and dust-asphalt ratio will be waived for 307-B, 307-BM, 307-BM2 and 307-C mixes.

Table 307.03-2: Mixture Design Properties

Mix [1]	Stability (minimum) lbf [2]	Design Void Content % [2]	Production Void Content, % [2]	VMA (minimum) % [2]	Dust-Asphalt Ratio [3]
307-B	2,000	4.0±0.2	3-5.5	11.5	0.6-1.5
307-BM	2,000	4.0±0.2	3-5.5	13.5	0.6-1.5
307-BM2	2,000	4.0±0.2	3-5.5	13.5	0.6-1.5
307-C	2,000	4.0±0.2	3-5.5	13.0	0.6-1.5
307-CS	2,000	3.0±0.5	1-5	---	---
307-CW	1,500	4.0±0.2	3-5	13.0	0.6-1.5

[1] To identify critical mixes and make appropriate adjustments, the mix design shall meet these design properties for the bitumen content range of Optimum Asphalt Cement ±0.25%.

[2] Tested according to AASHTO T 245 with 75 blows with the hammer on each end of the test specimen, using a Marshall Mechanical Compactor.

[3] The dust-asphalt ratio is the percent of the total aggregate sample that passes the No. 200 sieve, as determined by AASHTO T 11, divided by the percent asphalt in the total mix.

If the materials proposed for use do not meet the design criteria specified in Table 307.03-2, find other suitable sources of materials. If the material at the asphalt plant will not combine within the tolerances of the Job Mix Formula (JMF), provide a new design.

B. Recycled Asphalt Pavement and Recycled Asphalt Shingles

1. **Recycled Asphalt Pavement (RAP).** The Contractor may use asphaltic concrete removed from a Department project or other State Highway Agency project by an approved method and stored in a Department approved stockpile. RAP combined with the appropriate aggregate, asphalt cement, and anti-strip additive when required shall produce a mixture that meets **903.06** and **307**. The Contractor may incorporate RAP in the mixes specified in Table 307.03-3.

Table 307.03-3: Mixtures Using RAP

Mix Type	% RAP (Non-processed) [1]	Maximum % RAP (Processed) [2]	Maximum % RAP Processed & Fractionated [3]	Maximum Particle Size (inches)
307-ACRL	0	00	-	-
307-AS	0	10	10	-
307-A	15	20	35	1-1/2
307-B	15	30	35	1-1/2
307-BM	15	30	35	3/4
307-BM2	15	30	35	3/4
307-C	15	30	35	3/8
307-CW	15	30	35	1/2
307-CS	0	15	25	5/16

[1] "Non-processed" refers to RAP that has not been crushed and screened or otherwise sized prior to its use.

[2] "Processed" refers to RAP that has been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that listed in Table 307.03-3 prior to entering the dryer drum.

[3] "Fractionated" refers to RAP that has been processed over more than one screen, producing sources of various maximum particle sizes (e.g., 3/4 to 1/2 inch, 1/2 inch to #4, etc.). The Contractor may use the larger percentages of fractionated RAP specified only if individual fractions of two different maximum particle size are introduced into the plant as separate material sources for increased control.

All mixes shall contain at least 65% virgin asphalt.

The Contractor shall obtain a representative sample from the recycled material stockpile and shall establish a gradation and asphalt cement content. The Contractor shall determine the gradation and asphalt content of the recycled material at the beginning of a project and every 2,000 tons thereafter. The stockpile asphalt cement content for all recycled material shall not vary by more than 0.8%. The stockpile gradation tolerance for all recycled material on each sieve is specified in Table 307.03-4.

Table 307.03-4: Stockpile Gradation Tolerance

Sieve Size	Tolerance
3/8 inch and larger	± 10%
No. 4	± 8%
No. 8	± 6%
No. 30	± 5%
No. 200	± 4%

The Engineer will accept the mixture for aggregate gradation and asphalt content in accordance with **407.20.B**.

Provide a special mix design with asphalt content in the range of 5 to 7% where 307-C Mix is used as a surface on the shoulder.

Perform sampling and testing of the planings as well as new materials for bid purposes, and for the submission of the Job Mix Formula (JMF) as specified in **407.03**. Submit all additives to the Engineer for approval at the same time other materials are submitted for design verification.

After mixing, verify the moisture content of the total mix is no more than 0.1% as determined by oven drying. Provisions for lowering the temperature because of boiling or foaming shall not apply.

2. **Recycled Asphalt Shingles (RAS).** RAS may be included to a maximum of 3% of the total weight of mixture. The percentage of RAS used will be considered part of the maximum allowable RAP percentage. The ratio of added new asphalt binder to total asphalt binder shall be 65% or greater for all 307 mixes. Either the mix producer or the RAS supplier shall obtain a representative sample from the recycled material stockpile and establish a gradation and asphalt cement content as required. Determine shingle asphalt binder content according to AASHTO T 164 Method A, with a minimum sample size of 500 grams. Determine the gradation and asphalt content of the recycled material at the beginning of the Project and every 2,000 tons of recycled material used thereafter. The stockpile asphalt cement content for all recycled material shall not vary by more than 0.8%. All RAS material shall be processed

to a minimum 100% passing the 3/8 inch sieve and a minimum 90% passing the No. 4 sieve.

To conduct the gradation testing, air dry a 500 to 700-gram sample of processed shingle material, dry sieve over the 3/8-inch and No. 4 sieves, and weigh. For mix design purposes, the Contractor may use the aggregate gradation specified in Table 307.03-5 as a standard gradation instead of determining the shingle gradation according to AASHTO T 30.

Table 307.03-5: Standard Gradation (for Mix Design Purposes)

Sieve Size	Total Percent Passing
3/8 inch	100
No. 4	97
No. 8	95
No. 16	80
No. 30	60
No. 50	50
No. 100	40
No. 200	30

An aggregate bulk specific gravity (G_{sb}) of 2.650 may be used instead of determining the shingle aggregate G_{sb} according to AASHTO T 84. In addition, the effective binder available for mixing with additional aggregates shall be considered as 75% of the total binder content as determined by AASHTO T 164 and shall be the value listed as the RAS binder content on the JMF.

Scrap asphalt shingle shall not contain extraneous waste materials. Extraneous materials including, but not limited to, asbestos, metals, glass, rubber, nails, soil, brick, tars, paper, wood, and plastics, shall not exceed 0.5% by weight as determined on material retained on the No. 4 sieve. To conduct deleterious material testing, take a representative 500 to 700-gram sample of processed shingle material, place over the No. 4 sieve, and pick and weigh all extraneous waste material retained on the No. 4 sieve. Base the percent of extraneous material on the total sample weight.

RAS shall contain less than the maximum percentage of asbestos fibers based on testing procedures established by the Department, or State or Federal environmental regulatory agencies. Analyze a minimum of one sample of processed asphalt roofing material for every 500 tons of material processed for the presence of asbestos.

Before a JMF for a particular design is approved, submit the following, along with the materials and information specified in **407.03**:

a. Certification by the processor of the shingle scrap describing the shingle scrap content and source.

b. A 1000-gram sample of the processed RAS material for inspection (new designs only).

Stockpile RAS separate from other salvage material. Do not blend RAS material in a stockpile with other salvage material. Do not blend Manufacture Waste Scrap Shingles (MWSS) and Tear-Off Scrap Shingles (TOSS). In addition, do not blend virgin sand material with the processed shingles, to minimize agglomeration of the shingle material.

All RAS supplied to a Department project shall come from a certified shingle processor/supplier approved by the Division of Materials and Tests.

C. Anti-Strip Additive

Check asphaltic concrete mixtures (Grading A, AS, ACRL, B, BM, BM2, C, CS, and CW) for stripping by the following methods:

1. The Ten Minute Boil test for dosage rate and the Root-Tunnecliff procedure (ASTM D4867) for moisture susceptibility.

   Do not use the Root-Tunnecliff procedure (ASTM D4867) with the following mixtures: Grading A, AS, ACRL, and B.

2. For mixtures not requiring design, the Ten Minute Boil test for dosage rate and moisture susceptibility.

Mix an approved antistrip agent with the asphalt cement at the dosage as specified in **921.06.B**.

EQUIPMENT

307.04 Equipment

Provide equipment as specified in **407.04** through **407.08**.

If using recycled mix, modify the asphalt plant as approved by the Engineer to accommodate the addition of asphalt planings. If using a batch plant to produce recycled mix, heat the aggregate to a temperature that will transfer sufficient heat to the cold planings to produce a mix of uniform temperature within the specified range.

CONSTRUCTION REQUIREMENTS

307.05 General

Conform to the construction requirements specified in **407.09** and **407.11** through **407.17**.

307.06 Preparing the Subgrade, Sub-base, or Surface

The Plans will indicate whether the plant-mixed base is to be constructed on a treated or untreated subgrade or sub-base, on a granular base, or on an existing surface. Ensure that the surface upon which the plant mix base is to be constructed meets **205**, **207**, **302**, **303**, **304**, or **309**, whichever is applicable. If shown on the Plans, condition the surface as specified in **407.10**. Condition existing mineral aggregate base as specified in **310**. Construct prime coat or tack coat as specified in **402** or **403**, respectively.

Do not place AS/ACRL which cannot be covered by the next course of pavement within the same construction season.

Only place bituminous plant-mix base mixture on a surface that is dry and free of loose particles and other undesirable materials.

307.07 Thickness and Surface Requirement

Control thickness during the spreading operation by frequently measuring the freshly spread mixture to establish a relationship between the uncompacted mixture and the completed course. Thickness or spread rate in pounds per square yards shall be within reasonably close conformity with that shown on the Plans. Each course shall have a thickness after compaction of not more than 4 inches, unless otherwise approved by the Engineer.

The surface of the base shall meet the requirements specified in **407.18**, and when tested in accordance with **407.18**, the deviation of the surfaces from the testing edge of the straightedge shall not exceed the amounts specified in Table 307.07-1.

Table 307.07-1: Maximum Surface Deviation

Mixture	Maximum Deviation (inches)
Grading A, ACRL, and AS	1/2
Grading B, BM, BM2, C, CS, and CW	3/8

COMPENSATION

307.08 Method of Measurement

The Department will measure Mineral Aggregate, including Mineral Filler when required, and Asphalt Cement for Bituminous Plant Mix Base and other related items in accordance with **407.19**.

307.09 Basis of Payment

The Department will pay for accepted quantities at the contract prices in accordance with **407.20**.

For bidding purposes, use the asphalt cement content specified in Table 307.09-1 for the designated mix.

Table 307.09-1: Asphalt Cement Content

Mix Type	Asphalt Content
307 A	4.0%
307 AS	3.5%
307 ACRL	3.5%
307 B	4.3%
307 BM	5.0%
307 BM2	5.0%
307 C	5.0%
307 CW	6.0%
307 CS	6.5%

If the Engineer sets an asphalt content other than that specified in Table 307.09-1, the Department will calculate a price adjustment, based on the asphalt content set by the Engineer and the Monthly Bituminous Index for the specific grade asphalt on the mix design, in accordance with **407.20**.

PART 4 – FLEXIBLE SURFACES

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DESCRIPTION

401.01 Description

This work consists of furnishing and placing one or more courses of aggregates, and an admixture if required, on a prepared surface.

MATERIALS

401.02 Materials

Provide materials as specified in:

Aggregate, Type B **903.05.B**
Calcium Chloride, Type I, Type 2, or
Calcium Chloride Liquor **921.02**

The Engineer will accept aggregate for gradation as specified in **303.02**.

EQUIPMENT

401.03 Equipment

Provide equipment as specified in **303.06**.

CONSTRUCTION REQUIREMENTS

401.04 Construction Methods

Obtain the Engineer's approval of the completed roadbed before placing any surface material upon it.

On projects not requiring placement of surface material over the entire width of the roadbed, blade sufficient subgrade material from the subgrade, forming windrows on the shoulders from which to complete the compacted shoulders to the required cross-section after completing the surface course.

The surface course material may be spread with mechanical spreaders, dumped in windrows, or end dumped. Use approved machine methods to spread material dumped in windrows or end dumped, taking care to destroy all compaction planes caused by dumping or hauling over the material.

Construct the mineral aggregate surface in layers as shown on the Plans, with spreading, machining, sprinkling, and compaction operations progressing until the work is in reasonably close conformity to the lines, grades, and cross-sections shown on the Plans or established by the Engineer. Construct and maintain the surface of each layer to produce a uniform texture and to firmly key the aggregate. Uniformly apply water over the surface material during compaction in the amount necessary to ensure proper consolidation.

Roll each layer using approved rollers until the surface is thoroughly compacted and approved by the Engineer. If the required compacted depth of the surface course exceeds 6 inches, construct the surface course in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches; however, if using vibrating or other approved types of special compacting equipment, the Contractor may increase the compacted depth of a single layer of the surface course to 8 inches with the Engineer's approval.

If two or more sizes or types of aggregates are to be blended on the road, spread the different aggregates separately using an approved mechanical spreader that can be adjusted to spread the materials in the proper proportions.

After spreading the material, and additive if specified, perform mixing using an approved mechanical mixer that is capable of producing a thorough and intimate mixture of aggregates, additive, and water.

Incorporate calcium chloride, if required, as specified in **303.08.B**.

401.05 Thickness and Surface Requirements

The thickness and surface of the completed Mineral Aggregate Surface shall meet **303.12** and **303.13**.

COMPENSATION

401.06 Method of Measurement

The Department will measure:

1. Mineral Aggregate Surface by the ton in accordance with **109**.

2. Water added to the materials at the direction of the Engineer by the M.G. (1,000 gallons) using calibrated tanks or distributors, or accurate water meters.

3. Calcium Chloride by the ton in accordance with **303.14.D**.

When measuring Mineral Aggregate Surface, the Department will deduct the weight of all surface moisture on the aggregate at the time of weighing in excess of 8%.

401.07 Basis of Payment

The Department will pay for accepted quantities of Mineral Aggregate Surface, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Mineral Aggregate	Ton
Calcium Chloride	Ton
Water	MG

SECTION 402 – PRIME COAT

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DESCRIPTION

402.01 Description

This work consists of applying bituminous material, and cover material if required, on a designated base.

MATERIALS

402.02 Materials

Provide materials as specified in:

Aggregate for Cover Material, Size 7, 8, or 78 ..... **903.13**
Emulsified Asphalt, Grade AE-P, CAE-P, or tack coats in 403.02 ..... **904.03**

When prime coat quantity is 6 tons or more, AE-P or CAE-P will be applied unless otherwise directed by the Department.

Apply Emulsified Asphalt, Grade AE-P or CAE-P, at a temperature range of 60 to 140 °F.

When prime coat quantity is less than 6 tons, the use of emulsions for tack coat in **403.02** will be permitted. Dilute all tack coat emulsions with water at 1 part water to 1 part emulsion.

EQUIPMENT

402.03 Equipment

Provide a power broom or other mechanical sweeping equipment, bituminous heating equipment, a water sprinkler, a pressure distributor, and such other equipment and small tools as may be required to perform the work in a satisfactory manner.

The distributor shall be designed, equipped, maintained, and operated so that bituminous material at even heat may be applied uniformly on variable surface widths at readily determined and controlled rates from 0.05 to 0.5 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate of plus or minus 0.02 gallons per square yard.

Distributor equipment shall include: a tachometer, pressure gauges, accurate volume measuring devices, a calibrated tank, a thermometer for measuring the temperature of the material in the tank, a power unit for the pump, and full circulation spray bars that are adjustable laterally and vertically.

CONSTRUCTION REQUIREMENTS

402.04 Limitations

When applying bituminous prime coat, adhere to the same seasonal and temperature limitations as those specified for the succeeding stage of construction. The Contractor may apply the prime coat to a surface that is slightly damp, but never to a wet surface.

402.05 Preparing the Surface

Prepare the surface to be primed as specified in **303** or **310**, whichever is applicable.

If delays in the priming operation occur, maintain or rework the prepared surface to meet the requirements of **303** or **310**, whichever is applicable, before resuming the priming operation.

402.06 Applying Priming Material

Before applying the treatment, obtain the Engineer's approval of all areas to be treated. Apply and spread the bituminous material uniformly over the width of the section to be primed using a pressure distributor. The surface to be primed shall be damp. Do not apply prime coat if there is standing water on the surface or if it has dried. If there is delay between preparing the surface and priming operation occur, lightly rewet the surface.

If using AE-P or CAE-P, the Engineer will designate the application rate within the extreme limits shown on the Plans. If using emulsion other than AE-P or CAE-P diluted at 1:1, the Engineer will designate the application rate of application 1.5 times the rate specified for AE-P or CAE-P.

Maintain the application temperatures within the ranges specified in **402.02**.

To correct areas containing an excess or deficiency of priming material, add blotter material or bituminous material, as directed by the Engineer.

Protect all structures and concrete surfaces from the bituminous material during construction.

402.07 Applying Cover Material

If the bituminous material fails to penetrate before the time the roadway must be used by traffic, spread dry cover material at a rate established by the Engineer, between 8 and 12 pounds per square yard, to prevent damage to the primed surface. Avoid applying an excess of cover material.

402.08 Maintenance and Protection

Maintain the prime coat and the surface intact until it has been covered by the wearing surface or the project is completed. Do not place any succeeding stage of construction upon the prime coat until it has properly cured.

Repair spots where the prime coat may have failed, due to disintegration of the underlying surface material or other reasons, as follows:

1. Lightly dampen the exposed areas.

2. Refill such areas with approved material and thoroughly compact to conform with the surrounding surface.

3. Apply bituminous prime material to the surface with a hand spray.

If this method cannot produce satisfactory repairs, fill the depressions with approved mixtures of bituminous material and fine aggregate, and compact the mixture to conform to the surrounding surface.

COMPENSATION

402.09 Method of Measurement

The Department will measure:

1. Bituminous material and cover material by the ton in accordance with **109**.

2. Water used at the direction of the Engineer to dampen the base before applying bituminous materials by the M.G. (1,000 gallons), using calibrated tanks or distributors, or accurate water meters. Water used to dilute emulsified asphalt for tack coat will not be measured.

The Department may use net certified weights as a basis of measurement for cover material aggregate, subject to correction for aggregate that is lost, wasted, or otherwise not incorporated in the Work.

402.10 Basis of Payment

The Department will pay for accepted quantities of Prime Coat, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Bituminous Material	Ton
Cover Material	Ton
Water	MG

If using emulsion other than AE-P or CAE-P, payment will be based on the undiluted weight of the emulsified asphalt. No payment will be made for the water required to dilute of the tack coat.

If the prime coat is damaged due to causes beyond the Contractor's control, the Department will pay, at the contract unit prices, for mineral aggregate and bituminous material used to repair the damaged areas as specified in **402.08**.

SECTION 403 – TACK COAT

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DESCRIPTION

403.01 Description

This work consists of furnishing and applying emulsified asphalt to a previously prepared base or surface course to provide bond for a superimposed course.

MATERIALS

403.02 Bituminous Materials

Provide materials as specified in:

Emulsified Asphalt, SS-1, SS-1h, CSS-1, CSS-1h, TST-1P, CQS-1h, CQS-1hp, RS-1, CRS-1……**904.03**
Approved Trackless Tack……... QPL

Apply tack coat at the temperature ranges specified in Table 403.02-1.

Table 403.02-1: Tack Coat Application Temperatures

Material	Temperature Range
SS-1, SS-1h, CSS-1, TST-1P, CQS-1h, CQS-1hp, and CSS-1h	70 to 160 °F
Approved Trackless Tack from the QPL	Per Manufacturer's Recommendation

Dilution of asphalt emulsion used for tack coat on hot mix asphalt paving projects after leaving the terminal is not allowed. Apply the emulsion as delivered from the terminal.

EQUIPMENT

403.03 Equipment

Provide a power broom, equipment for heating bituminous material, a pressure distributor meeting the requirements of **402.03**, and such other equipment and small tools as may be required to perform the work in a satisfactory manner.

403.04 Preparing the Surface

Prepare the designated surface as specified in **404.05**. Ensure that the surface is dry when applying tack coat.

403.05 Applying Emulsified Asphalt

A. Emulsified Asphalt

Immediately after cleaning the surface, apply emulsified asphalt with the pressure distributor at a rate, established by the Engineer, within the range of 0.05 to 0.10 gallons per square yard of applied emulsion. If the bituminous material is to be placed upon a milled surface, apply at a rate, established by the Engineer, within the range of 0.08 to 0.12 gallons per square yard of applied emulsion. When applying tack coat on freshly-placed asphalt, lower application rates may be permitted, provided a full coverage application is still achieved.

For slurry seal and microsurface, apply a tack coat of SS-1h, CQS-1h, or CQS-1hp emulsion. The tack coat shall consist of one part emulsion and three parts water. The application rate shall be 0.10 to 0.15 gallons per

square yard of the diluted emulsion. The Engineer will determine the actual application rate.

Protect the surfaces of trees and structures adjacent to the area being treated to prevent their being splattered or marred.

Allow the emulsified asphalt to break prior to paving the next course. Apply tack coat only so far in advance of the paving operations as is necessary to obtain this proper condition of tackiness. Protect the tack coat from damage until the next course is placed.

B. Test Strip

When setting up an initial roller pattern and density test strip for the first layer of asphalt mixture, prepare a tack coat test strip to demonstrate that the proposed equipment and methods will achieve proper application of tack coat.

For the test strip, apply the tack material at a rate of between 0.05 and 0.10 gallons of applied emulsion per square yard. If placing the bituminous material upon a milled surface, apply the tack material at a rate of between 0.08 and 0.12 gallons applied emulsion per square yard.

In all cases, ensure that the application will result in a minimum double overlap of the actual tack spray as it lands on the surface. Adjustment of the spray-bar and the nozzles may be necessary to achieve this minimum double overlap. Corn-rows or any other pattern that would result in less than double overlap coverage of the tack coat is not acceptable for the tack application. The goal is to have a very thin but uniform coating of asphalt left on the surface when the emulsion has broken.

Once the test strip has been demonstrated and approved by the Engineer, use the same procedure and application rates for the entire project or until another design is proposed and accepted.

C. Fog Sealing

When the Contract requires bituminous material for fog sealing of shoulders, provide emulsified asphalt meeting **403.02** or an item from QPL 40A. Apply diluted emulsified asphalt at a rate of 0.10 to 0.15 gallons per square yard based on a dilution rate of one part emulsified asphalt to one part water. This application may require two equal increments if run-off occurs.

COMPENSATION

403.06 Method of Measurement

The Department will measure Emulsified Asphalt for Tack Coat and Fog Sealing by the ton, as delivered from the terminal, in accordance with **109**. The Department will make no direct payment for water used to dilute Emulsified Asphalt for Fog Sealing.

403.07 Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Emulsified Asphalt for Tack Coat	Ton
Emulsified Asphalt for Fog Seal	Ton

The Department will measure and pay for the work required to prepare the designated surface, as provided for under **403.04**, in accordance with the applicable Section or Subsection under which the work is performed.

SECTION 405 – BITUMINOUS SEAL COAT

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DESCRIPTION

405.01 Description

This work consists of constructing a bituminous seal coat consisting of one or more applications each of bituminous material and cover aggregate.

MATERIALS

405.02 Materials

Provide materials as specified in:

Mineral Aggregate, Size Nos. 7, 8, 78, 89 ..... **903.13**
Mineral Aggregate **903.14**
Emulsified Asphalt, CRS-2p **904.03**

Apply seal coat at a temperature range of 60 to 140 °F.

EQUIPMENT

405.03 Equipment

Provide a power broom or other mechanical sweeping equipment, equipment for heating bituminous material, a pressure distributor meeting the requirements of **402.03**, two pneumatic-tire rollers, self-propelled mechanical aggregate spreading equipment that can be adjusted to spread accurately at the specified rate, and such other equipment and small tools as may be required to perform the work in a satisfactory manner.

CONSTRUCTION REQUIREMENTS

405.04 Limitations

Only apply bituminous material:

1. When the designated surface is dry, firm, and properly cured;

2. Between April 15 and October 1; and, unless otherwise directed,

3. When the ambient temperature in the shade and away from artificial heat is 70 °F or more.

405.05 Preparing the Designated Surface

Before placing seal coat, clean all surfaces to be sealed by sweeping with a motorized broom to remove any loose material. Clean depressions and cracks not reached by the power broom using hand brooms or pressurized air.

Remove pavement markers and adhesives. Abrade all types of existing pavement markings. Work shall be accomplished without the pavement being gouged or damaged and in a manner which ensures the bituminous treatment will adhere in all areas applied. Work shall be performed to the satisfaction of the Engineer.

Cover any utility installations to prevent adherence of the bituminous mixture. Suitable covering includes plywood disks, sand, craft paper, roofing felt or other approved methods. Remove the protective coverings before opening the road to traffic. The cost for these adjustments shall be included in the bid price for other items.

The Plans will indicate whether the surface is to be constructed on a treated or untreated subbase, a granular base, an asphalt base, or on an existing surface. The surface of the base or sub-base upon which the construction is to be placed shall meet the requirements of the applicable Section of Part 3, Bases and Subgrade Treatments, of these Specifications.

Condition existing surface, if called for on the Plans, as specified in **407.10**. Condition existing mineral aggregate base as specified in **310**.

Construct and maintain Prime Coat or Tack Coat, if shown on the Plans, as specified in **402** or **403**, respectively.

405.06 Application

A. Applying Bituminous Material

Have all equipment calibrated prior to starting work. The TDOT inspector shall be present during calibration to determine aggregate spread rate and distributor rates. Distributor trucks shall have proper calibration of spray equipment. Spray nozzles should be clean, properly angled, and appropriately sized for the desired application rate. Stop work if the distributor is not applying material properly, such as gaps in application or streaking.

Place a 500-foot test strip for the bituminous seal coat at the beginning of the project to assure proper coverage and proper equipment calibration. The test section is to verify break time of emulsion and chip retention. The test strip shall be able to carry normal traffic within 3 hours. If normal traffic cannot be carried, the emulsion shall be adjusted and another test strip is required.

At least 14 working days before the scheduled start of construction of any bituminous seal coat, submit a sample of aggregate intended for use for the determination of the appropriate application rates of bituminous material and aggregate. Apply emulsified asphalt by pressure distributor at a uniform rate in accordance with Table 405.06-1 below. The exact rate will be established by the Engineer.

Table 405.06-1: Application Rates for Bituminous Material

Aggregate Size (per 903.22)	Aggregate Spread Rate (lb/yd^2)	Emulsion Shot Rate (gal/yd^2)
7	25 – 30	0.30 – 0.45
78	22 – 28	0.28 – 0.38
8	20 – 25	0.20 – 0.35
89	17 – 23	0.17 – 0.28

Before beginning each spread, place building paper across the roadway surface with the forward edge exactly coinciding with the end of the preceding covered spread. Start distributors on the paper, the width of which shall allow the full force of all nozzles to be in effect before the forward edge of the paper is reached. If required by the Engineer, also stop the spread on building paper. Remove the paper immediately after its use, and dispose of properly. Immediately correct all defects in application.

The length of spread of bituminous material shall not exceed that which trucks loaded with cover material can immediately cover.

The spread of bituminous material shall not extend more than 6 inches wider than the width covered by the cover material. Do not allow the bituminous material to chill or otherwise impair retention of the cover material.

Do not allow traffic on the bituminous material until it has been covered with mineral aggregate.

Treat areas that are inaccessible to the distributor with either hand sprays or pouring pots as directed by the Engineer.

B. Application of Double Bituminous Surface Treatment

1. First Application

Apply the first application of emulsified asphalt using pressure distributors at a uniform rate established by the Engineer within the range of 0.30 to 0.38 gallons per square yard. Apply each spread of bituminous material to not be more than 6 inches wider than the

width covered by the immediate spread of cover aggregate. Each width of spread shall not be less than half the surface to be treated.

Before beginning each spread, place building paper across the roadway surface with the forward edge exactly coinciding with the end of the preceding covered spread. Start distributors on the paper, the width of which shall allow the full force of all nozzles to be in effect before the forward edge of the paper is reached. If required by the Engineer, also stop the spread on building paper. Remove the paper immediately after its use, and dispose of properly. Immediately correct all defects in application.

Treat areas that are inaccessible to the distributor with hand sprays or pouring pots as directed by the Engineer.

If treating less than the full width of the roadway, do not spread the aggregate on the inside 6 inches of either the first or second application until the adjacent lane has been treated. Immediately following each application, uniformly cover the applied bituminous material with Size No. 7 mineral aggregate that is reasonably free of surface moisture.

Spread the aggregate at a rate between 24 and 30 pounds per square yard, as established by the Engineer, using a self-propelled mechanical spreader; except on short projects of ½ mile in length or less, self-propelled mechanical spreading equipment will not be required. Back the truck on the aggregate being spread, without driving on or over uncovered bituminous material.

The length of bituminous material spread shall not exceed that which trucks loaded with cover material can immediately cover.

2. **Second Application**

Apply the second application of emulsified asphalt in the same manner as the first application, at a uniform rate established by the Engineer within the range of 0.20 and 0.35 gallons per square yard.

Spread mineral aggregate, Size No. 8, in the same manner as the first spread at a rate established by the Engineer within the range of 16 to 28 pounds per square yard.

Immediately after each spread of cover aggregate, broom to achieve uniform coverage. Use a power source, which is independent of the drive train that propels the equipment, to power the revolving brooms of mechanical sweeping equipment. Place additional aggregate by hand on thin or bare areas.

405.07 Spreading and Rolling Aggregate

A. Spreading

Immediately after bituminous material has been applied, no more than two minutes, spread and embed the mineral aggregate cover in the bituminous material. Spread the aggregate as close to the application of bituminous material as is practicable, and cover each distributor load applied immediately. Aggregates shall be moistened and visually damp at the time of placement.

Spread the aggregate in accordance with the rates specified in Table 405.06-1. The exact rate will be established by the Engineer. Back the truck on the aggregate being spread, without driving on or over uncovered bituminous material. If treating less than the full width of roadway, do not spread the aggregate on the inside 6 inches of the bituminous spread until the adjacent lane is treated. Immediately after spreading the aggregate, perform hand-brooming to achieve uniform coverage. Place additional aggregate by hand on thin or bare areas.

The speed of the spreader shall be such that the aggregates are not rolling over, and starting and stopping of the spreader is minimized. Use of previously used (swept) aggregates is not permitted.

B. Rolling – Bituminous Seal Coat

Immediately after distributing the aggregate, roll the entire surface by moving in a longitudinal direction, beginning at the outer edges and progressing toward the center of the roadway, with each trip of the roller overlapping the previous trip by half the width of the rear wheel. The amount and sequence of rolling shall be as directed by the Engineer. Complete the initial rolling of the aggregate within 1 hour after applying the bituminous material.

Use power brooms to correct irregularities by sweeping the aggregates from areas of thick or heavy distribution to areas of thin or light distribution. Then continue rolling until the aggregate is thoroughly

embedded in the bituminous material. The Engineer may require additional rolling at a later date. Redistribute excess or loose aggregate that was thrown out of place.

Slow moving traffic may use the section or roadway upon which the aggregate has been spread.

C. Rolling and Curing – Double Bituminous Seal Coat

Immediately after spreading and brooming the cover aggregate, roll the entire surface, beginning at the edges and progressing to the center. Begin rolling within 30 minutes after spreading the aggregate. The amount and sequence of rolling shall be as directed by the Engineer.

Allow the first application of bituminous material and aggregate to cure for as long as deemed necessary by the Engineer before beginning the second application.

For the second application of bituminous material and cover aggregate, repeat the same rolling and curing procedures as required for the first application.

The Contractor may allow slow-moving traffic to use sections of the roadway where the bituminous material has been covered with mineral aggregate.

405.08 Shoulders

Restore shoulders that have been disturbed by the Contractor's construction operations at no cost to the Department. Remove all objectionable material placed on the shoulders by the Contractor as directed by the Engineer.

Construct shoulders, when specified, as provided for under **208**.

405.09 Maintenance and Protection

Maintain in a satisfactory condition each completed section of seal coat until the entire Project is complete. Maintenance shall include making repairs where failures occur, and maintaining the seal coat in a smooth uniform condition; and brooming, dragging, and rolling when required.

After the final application, maintain the work in a satisfactory condition for at least 10 calendar days. If all other requirements of the Contract have been fulfilled, the Department will not charge working time during the 10-day maintenance period against the Contract time.

For final cleanup, sweep up all excessive quantities of loose, dislodged cover aggregate that may have collected along the edge of the completed seal coat, and dispose of this material as directed by the Engineer.

COMPENSATION

405.10 Method of Measurement

The Department will measure Mineral Aggregate and Bituminous Material by the ton in accordance with **109**. The Department may use net certified weights as a basis of measurement for mineral aggregate, subject to correction for aggregate that is lost, wasted, or otherwise not incorporated into the Work.

405.11 Basis of Payment

A. General

The Department will pay for accepted quantities of Bituminous Seal Coat, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Bituminous Material	Ton
Mineral Aggregate	Ton

The Department will measure and pay for the work required to prepare the designated surface, as provided for under **405.05**, in accordance with the applicable Section or Subsection under which the work is performed.

B. Adjustments

Specific Gravity. In cases where the Bulk SSD specific gravity of the mineral aggregate exceeds 2.80, the Department will adjust the tonnage of mineral aggregate for payment by multiplying the tonnage of mineral aggregate used by a specific gravity of 2.80 and dividing by the higher specific gravity

SECTION 407 – BITUMINOUS PLANT MIX PAVEMENTS (GENERAL)

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DESCRIPTION

407.01 Description

This Section **407** is applicable to all types of bituminous pavements of the asphalt plant mix type as described in **307**, **313**, and **411**. Deviations from these general requirements will be indicated in the specific requirements for each pavement type.

This work consists of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with this Section **407** and the specific requirements of the pavement type under contract.

MATERIALS

407.02 Materials

Provide materials as specified in:

Aggregates	**903**
Mineral Filler	**903.16**
Bituminous Materials	**904**
Chemical Admixtures and Additives	**921.06.B**

Separate aggregate into coarse and fine aggregate stockpiles. If stockpiling of coarse aggregate causes segregation, separate into coarse and medium coarse stockpiles.

Store each size and type of aggregate in a separate pile, bin, or stall. Maintain the storage yard in an orderly condition, clearing a walkway between stockpiles that are not separated by partitions. Make the stockpiles readily accessible for sampling.

The Engineer will conditionally accept the mineral aggregate for quality in the stockpile at the producer's site. The Engineer may conditionally accept the bituminous material at the asphalt terminal. The Engineer will accept for aggregate gradation and asphalt cement content from hot bin samples or sample(s) taken from the completed mix at the asphalt plant after it has been loaded onto the trucks for transport to the Project.

If anti-stripping additive, other than hydrated lime, meeting **921.06.B.1** is required, use approved in-line blending equipment, as specified in **407.04.A.6**, to add it at the mixing plant or inject it at the asphalt terminal. Manufacture's documentation that asphalt binders will continue to meet requirements listed in **904** after the anti-stripping additive is added shall be provided by the contractor with the mix design submittal. For mix designs submitted more than six months in advance, the documentation shall be resubmitted prior to use of the mix design with updated test results.

If the resurfacing plans call for a Performance Grade (PG) asphalt mix with properties greater than that of PG 64-22 and this is the only asphalt grade on the Project, the Contractor may use either the asphalt grade shown on the Plans or an asphalt grade equal to or better than PG 64-22 for driveways and business entrances unless otherwise directed by the Engineer. The Department will pay for this material at the same unit price as bid for the

asphalt or asphalt mix. Mark the material tickets "**FOR DRIVEWAYS AND BUSINESS ENTRANCES ONLY**" at the point of delivery.

If using a warm mix asphalt additive meeting **921.06.B.3**, use approved blending equipment to add it at the mixing plant, or deliver it premixed with the asphalt cement.

For 411-OGFC mixtures, include a stabilizing additive listed on the Department's Qualified Products List (QPL). Do not use fiber pellets. Slag wool fiber or cellulose fiber shall be blown into the asphalt plant measured by a flow meter or sensing device that is accurate to within plus or minus 10% of the amount required. For batch plants, add fibers in to the pugmill or weigh hopper. For drum plants, place the fiber line 1 foot upstream of the asphalt binder line so that the fibers are captured by the asphalt binder before being exposed to high-velocity gases in the drum. The minimum additive for a slag wool fiber shall be 0.4% and the minimum for a cellulose fiber shall be 0.3% of the total mix. The addition of a stabilizing additive material (fiber) shall be included in the cost of the asphalt cement.

407.03 Composition of Mixtures

A. General

Develop a bituminous mixture composed of aggregate (coarse, fine, or mixtures thereof), mineral filler if required, anti-strip additive if required, and bituminous material. Ensure that the aggregate fractions are sized, uniformly graded, and combined in such proportions so that the resulting mixture will meet the grading and physical properties of the approved Job Mix Formula (JMF).

B. Gradation and Bituminous Material Requirement

The requested aggregate gradation and bituminous material percentages shown on the JMF shall be within the design ranges specified in **903**, **307**, and **411**, respectively. Establish a recommended asphalt cement content for all mixes, with the final optimum asphalt cement content to be determined by the Engineer.

C. Job Mix Formula (JMF)

1. **General.** At least 14 working days before the scheduled start of production of any asphaltic paving mixture, submit a proposed Job Mix Formula (JMF) and Laboratory Design in electronic form,

where applicable, prepared in accordance with the Marshall Method of Mix Design (Asphalt Institute, MS-2), as modified by the Department, or by Gyratory Compaction (AASHTO T 312). Regardless of which method is used, prepare trial blends with at least four different asphalt contents (at least two above the optimum and two below the optimum).

When using the Marshall method of compaction, compact the specimens to 75 blows per side. When using the gyratory method of compaction, compact specimens to 65 gyrations.

All 411-OGFC design procedures shall follow the most current version of National Asphalt Pavement Association (NAPA) Publication IS-115, "Design, Construction and Maintenance of Open-Graded Friction Courses" except where modified herein. Design the OGFC using a Marshall compaction hammer at 50 blows or a standard gyratory compactor at 50 gyrations.

Provide the following information with JMF submittals:

a. The specific project on which the mixture will be used.

b. The source and description of all materials to be used in the mix.

c. The gradations and approximate proportions of the raw materials as intended to be combined in the paving mixture.

d. A single percentage of the combined mineral aggregate passing each specified sieve. Plot the combined aggregate gradation on a gradation chart with sieve sizes raised to the 0.45 power to ensure a well graded mix.

e. The Loss on Ignition (LOI) results on the combined aggregate of the mixture used as a wearing course.

f. The Bulk Specific Gravity, Apparent Specific Gravity, and absorption on the combined mineral aggregate in the paving mixture (AASHTO T 84 and T 85).

g. The fractured face count and glassy particle count of the plus No. 4 material, if applicable.

h. A single percentage of asphalt by weight of total mix intended to be incorporated in the completed mixture.

i. The dosage rate and source of anti-stripping additive, if required, meeting the requirements of **921.06.B.1**, to be added to the asphalt.

j. The maximum specific gravity of the asphalt mixture (AASHTO T 209).

k. A single temperature at which the mixture is intended to be discharged from the plant.

l. Evidence that the completed mixture will conform to all physical requirements specified in **903.06** and **307.03.A** or **903.11** and **411.03.B**; however, for mixes designed according to AASHTO T 312, the stability and flow requirements will be waived and the resistance to rutting requirements for surface mixtures must be met.

m. The tensile strength ratio (TSR) indicating the stripping and moisture susceptibility characteristics of the mix.

n. To identify critical mixes and make appropriate adjustments, the mix design shall meet the required design properties for stability, flow, voids in mineral aggregate (VMA), and production void content as specified in **307.03** and **411.03** at the bitumen content range of Optimum Asphalt Cement plus or minus 0.25%.

Establish the laboratory mix and compaction temperatures for the JMF in accordance with Table 407.03-1.

Table 407.03-1: Laboratory Mix and Compaction Temperatures

PG Binder Grade	Lab Mix Temperature (°F)	Lab Compaction Temperature (°F)
64-22, 67-22	Per temp./visc. Chart	Per temp./visc. Chart
70-22	320 – 345	295 – 320
76-22	320 – 345	305 – 330
82-22	320 – 345	305 – 335

Perform any additional laboratory testing of the mix using the laboratory mix and compaction temperatures listed on the approved JMF, with a tolerance of plus or minus 5 °F for each temperature.

A Certified Laboratory Technician shall prepare and sign the Laboratory Design. To be certified, the technician shall have completed the Marshall Method of Mix Design School conducted by the Department, including the written and lab performance testing.

2. **Revision of Job Mix Formula.** The approved JMF shall remain in effect until the Engineer authorizes a change in writing. The Contractor, at any time after construction has started, may request that the JMF be revised, provided evidence is shown that the revision is necessary, and the revised aggregate gradation will meet all applicable gradation requirements.

   Submit a revised JMF if, during the test strip construction and mix design/production verification procedure, changes are made to the mixture to comply with the specified criteria.

   Provide a new design for any change in source of materials.

   Submit all requests for design mix adjustments, redesigns, and new design mixes in writing to the Engineer for approval.

3. **Resistance to Plastic Flow.** Include, with the submitted JMF, test data showing that the material as produced will meet **307.03.A** or **411.03.B** when tested according to AASHTO T 245. Determine the bulk specific gravity of the laboratory compacted bituminous mixture (Marshall specimens) according to AASHTO T 166. Mixes

designed according to AASHTO T 312 are exempt from AASHTO T 245.

For surface mixtures used on roads with greater than 5,000 ADT, designed with the gyratory compactor (AASHTO T 312), include sufficient raw materials (aggregate and asphalt cement) with the submitted JMF so that the Central Laboratory may conduct rut testing in accordance with AASHTO T 340. The maximum allowable rut depth shall be 0.35 inches for roads with greater than or equal to 10,000 ADT and 0.40 inches for roads with 5,000 to 10,000 ADT.

Base the percent voids in the total mix on the maximum specific gravity of the bituminous mixture (Rice Gravity) according to AASHTO T 209. Calculate the voids in mineral aggregate (VMA) using the effective specific gravity of the aggregates.

D. Contractor's Quality Control

1. **General.** Assume responsibility for the quality of construction and materials incorporated in the Work. Provide and maintain a quality control system that will provide reasonable assurance that all materials conform to specification requirements.

   Conduct all quality control sampling and testing according to the approved Quality Control Plan and the Department's Policies on Sampling and Testing Procedures and Sampling of Asphalt Mixes for Verification of Laboratory Design. The requirements for the Contractor's quality control sampling and testing will remain in effect until final Project acceptance.

2. **Contractor Quality Control System.** Develop, implement, and maintain a quality control system that will provide reasonable assurance that all materials and products submitted to the Department for acceptance conform to the specified requirements.

   a. **Quality Control Technician.** Ensure that a Quality Control Technician, who is currently certified by the Department as a Certified Asphalt Plant Technician, is present at the asphalt plant during mix production. If the Department finds that the Quality Control Technician cannot perform as required by the position, the Department will revoke the certification and require replacement with a certified technician.

b. **Documentation.** Document all quality control procedures, inspections, and tests and make this information available for review by the Department throughout the life of the Contract. Maintain adequate records of all inspections and tests. The records shall indicate the nature and number of tests performed, the number and type of deficiencies found, and the nature of corrective action taken as appropriate.

The Contractor's documentation procedures will be subject to the review and approval of the Department before the start of the work and to compliance checks during progress of the work. Provide copies of all charts and records documenting quality control tests and inspections to the Engineer on a daily basis.

c. **Charts and Forms.** Record all conforming and nonconforming inspections and test results on approved forms and charts, and keep these records current and complete. Maintain test results at the Contractor's plant site laboratory and make such records available to the Engineer at all times during the performance of the work. Chart test results for the various materials and mixtures on forms that meet the Engineer's requirements. Provide an example of each proposed chart and form to the Engineer. Supply all charts and forms to be used to record results.

d. **Corrective Actions.** Promptly correct all errors, equipment malfunctions, process changes, or other assignable causes that have resulted or could result in the submission of materials, products, and completed construction that do not conform to the specifications.

If the Engineer finds that the Contractor is not controlling its process and is making no effort to take corrective actions, the Engineer will require that plant operations be ceased until the Contractor can demonstrate that it can and will control the process.

e. **Laboratories with Measuring and Testing Equipment.** Provide a fully equipped laboratory at the production site as specified in **106.06**. This facility may be permanent or portable. Furnish the laboratory with the necessary testing equipment and supplies for performing Contractor Quality Control sampling and testing as well as Department Acceptance sampling and

testing. To assure accuracy, the Department will check the testing equipment periodically according to the Department's Procedure for Qualified Laboratories.

f. **Sampling and Testing.** Sampling and testing methods and procedures to determine quality conformance of the materials and products shall be in accordance with **106.04**. Address in the Quality Control Plan the taking of samples for material characteristics and the plotting of the test results on control charts.

g. **Alternative Procedures.** The Engineer may approve the use of alternative sampling methods, procedures, and inspection equipment if such procedures and equipment provide, as a minimum, the quality assurance required by the Contract. Before applying such alternative procedures, describe them in a written proposal and demonstrate, for the Engineer's approval, that their effectiveness is equal to or better than the Contract requirements.

h. **Minimum Mixture Quality Control Testing.** During production of the mixture, provide material that conforms to the approved JMF. Perform testing on mixtures to confirm conformance to the acceptance criteria and the JMF as follows. Mixes with a project total of less than 1,000 tons are exempt from all verification testing requirements unless deemed necessary by the Engineer.

1) Start Up Testing. Produce 500 tons of mixture at the beginning of production of each mixture to confirm that the mixture meets the follow requirements:

a) All mix requirements are within the tolerance defined in Table 407.03-2.

b) Gradation and Asphalt Content are within the tolerance for a 1.00 pay factor based on a single test per Table 407.20-2.

c) The average density on the test strip meets the requirements for 100% payment per Table 407.15-1.

Sample mixture for startup testing from one of the first ten trucks loaded of any mixture to complete this testing. Provide a technician certified by the Department in Asphalt Mix Design to perform all start up testing. All testing shall be done under the Department's supervision. Present all test results to the Department for approval of the mix verification.

If any of the above criteria fail verification, cease production. Make adjustments to the process and produce no more than 100 tons to retest the mixture. Once the mixture passes verification full production may proceed. If the retest fails, submit a modified JMF to the Engineer.

All nonconforming mix produced during the test strip construction is subject to acceptance and pay adjustment or removal per **407.20**.

Table 407.03-2: Mix Design Requirements

Property	Value
Maximum Theoretical Gravity	± 0.025 of Mix Design Value
Voids in Total Mix	As noted for production in **307.03** and **411.03**
Voids in Mineral Aggregate	Minimum as noted in **307.03** and **411.03**
Marshall Stability	Minimum as noted in **307.03** and **411.03**
Dust/Asphalt Ratio	As noted in **307.03** and **411.03**

2) Production Testing. Sample and perform testing for conformance of the mix to the JMF within the tolerances defined in Table 407.20-2 on a 1000 ton maximum lot basis throughout production**.** Consider the process to be out of control and cease plant operations if test results from a single lot fall below the 0.90 pay factor limit or consecutive

tests fall below the 0.95 pay factor as specified in Table 407.20-2. Make adjustments to the process and produce no more than 100 tons for testing purposes. If the retest fails, submit a modified JMF to the Engineer. The Department will not allow the project to resume unless some corrective action has been taken and documented. Once test results show results compliant with the 1.00 pay factor range full production may resume.

3) Volumetric Testing. On any project using modified asphalt cement, test all the mix design requirements per Table 407.03-2 for each half day of production. Record all results on control charts made available to the department. If results fall outside the tolerance established in Table 407.03-2 then the following applies:

a) Resample and retest.

b) If the retest meets the criteria continue on without interruption.

c) If the retest fails to meet criteria, cease production. Make adjustments to the process and produce no more than 100 tons for testing purposes. If this retest fails, submit a modified JMF to the Engineer. The Department will not allow resumption of the project unless some corrective action has been taken and documented. Once compliance is achieved, resume full production.

3. **Quality Control Plan.** At the beginning of each paving season, submit in writing the proposed Quality Control Plan for the Engineer's approval. Include in this plan the sampling, testing, and inspection activities, and the anticipated frequencies of each, which the Contractor will follow to maintain process control. This Quality Control Plan shall apply to all Department contracts for the calendar year. If a change is made to the Quality Control Plan during the year, communicate such changes to the Regional Materials Supervisor. Refer to the recommended series of sampling, testing, and inspecting activities shown in Table 407.03-3.

Table 407.03-3: Recommended Items for a Contractor Quality Control Plan

A. All Types of Plants

1. Stockpiles
   a) Determine gradation of all incoming aggregates.
   b) Inspect stockpiles for separation, contamination, segregation, etc.
   c) Conduct a fractured face count when gravel is used as coarse aggregate.
   d) Determine the percent of glassy particles in slag coarse aggregate.
   e) Determine gradation and asphalt content of recycled asphalt pavement when used as a component material.
2. Cold Bins
   a) Calibrate the cold gate settings.
   b) Observe operation of cold feed for uniformity.
   c) Ensure that bins have proper dividers to prevent materials from spilling over into adjacent bins.
3. Dryer
   a) Observe pyrometer for aggregate temperature control.
   b) Observe efficiency of the burner.
   c) Determine the percent dust coating on plus 4 material.
   d) Check dried aggregate for contamination due to incomplete combustion of fuel.
4. Hot Bins
   a) Determine gradation of aggregates in each bin.
   b) Determine theoretical combined grading.
5. Bituminous Mixture
   a) Determine percent bitumen.
   b) Determine mix gradation.
   c) Check mix temperature.
   d) Determine percent moisture in mix when recycled asphalt pavement is a component material.
   e) Determine Loss-On-Ignition (LOI) of aggregates in mix where applicable.
   f) Check the mix for uncoated aggregate.
   g) Ensure that handling procedures do not contribute to segregation of the mix.

B. Batch Plants

1. Batch Weights – Determine percent used and weight to be pulled from each bin to assure compliance with the JMF.
2. Check mixing time (both dry and wet).
3. Check operations of weigh bucket and scales.
4. Document accuracy of all weighing and metering devices for:
   a) Asphalt cement
   b) Aggregate
   c) Anti-strip additive

C. Drum Mixer Plant

1. Calibrate the cold feed and prepare a calibration chart for each cold gate.
2. Develop information for the synchronization of the aggregate feed and the bituminous material feed.
3. Determine moisture content of aggregate being fed into dryer.
4. Determine the percent dust coating on dried plus 4 material.
5. Check dried aggregate for incomplete combustion of fuel.
6. Document accuracy of all weighing and metering devices for:
   a) Asphalt cement
   b) Aggregate
   c) Anti-strip additive

Consider the activities identified in Table 407.03-3 to be normal activities necessary to control the production of asphalt concrete at an acceptable quality level. However, note that depending on the type of process or materials, some of the activities listed may not be necessary, and in other cases, additional activities may be required. The frequency of these activities will also vary with the process and the materials. When the process varies from the defined process average and variability targets, increase the frequency of these activities as necessary to restore proper conditions.

Plot and keep up-to-date control charts for all Quality Control Sampling and Testing. Provide control charts for the following:

(a) Extracted asphalt content
(b) Mix gradation
(c) Dust to asphalt ratio
(d) Maximum theoretical gravity (when required)
(e) Voids in total mix (when required)
(f) Stability (when required)

Post all current control charts in the asphalt lab where they can be seen.

The Contractor is responsible for formulating all design mixes with the exception of plant mix seal coat mixes. No lab design is required for **307** Grading A, AS, and ACRL mixes. However, establish the anti-strip additive dosage rate and verify compatibility of mixture materials by the ten minute boil test as specified in **407.03.E.2**. Submit all Contractor-furnished design mixes to the Department for approval prior to their use. Provide process control of all materials during handling, blending, mixing, and placing operations.

If recycled asphalt pavement (RAP) is approved for use as a component material in a hot bituminous mixture, the Contractor's Quality Control Plan shall include determination of the gradation and asphalt content of the RAP material at a minimum frequency of 1 stockpile sample per 2,000 tons used in the mixture.

E. Testing Procedures

Conduct the Tensile Strength Ratio (TSR), Stripping, and Loss on Ignition (LOI) testing in accordance with the following:

1. **Tensile Strength Ratio.** Perform testing for stripping and moisture susceptibility of the mixture according to ASTM D 4867, Standard Test Method for Effect of Moisture on Asphalt-Concrete Paving Mixtures. For all mixtures requiring design, except OGFC, follow ASTM D4867. For OGFC follow ASTM D4867 except as noted:

   a. Modify step 8.6.1 so that the three conditioned samples are subjected to a partial vacuum of 26 inches Hg for 10 minutes to whatever degree of saturation achieved.

   b. Subject the 3 conditioned samples to one freeze thaw cycle per note 6 listed in ASTM D4867 8.7. except as noted.

c. After 15h in freezer, remove samples and immediately immerse the still wrapped specimen in 77 °F water for 2 hours.

d. After 2 hours remove specimen from water bath and remove wrapping from specimen then immerse sample in 140 °F water bath for 24 hours.

All specimens tested for stripping and moisture susceptibility shall meet the criteria specified in Table 407.03-4.

Table 407.03-4: Criteria for Stripping and Moisture Susceptibility

Asphalt Cement	Minimum Tensile Strength	Minimum TSR
Polymer Modified	100 psi	80%
Non-Polymer Modified	80 psi	80%
411 OGFC	50 psi	80%

2. **Ten Minute Boil Test (Stripping)**

a. **Field Test.** Test the completed mix for stripping at the asphalt plant as follows:

1) From a sample of the completed mix, visually select a minimum of 50 grams of the plus No. 4 material and place immediately in boiling water.

2) Continue to boil for 10 minutes, pour off water, and place coated aggregate on a paper towel.

3) Perform a visual inspection to verify that the coated aggregate shows no evidence of stripping.

b. **Laboratory Test.** Determine the dosage rate for anti-stripping additive in the laboratory as follows:

1) Wash and surface dry 50 grams of the mineral aggregate passing the ½-inch sieve and retained on the No. 4 sieve.

2) Thoroughly coat the selected aggregate with the blend by stirring the mixture heated to 250° F.

3) Immediately place the material in boiling water.

4) Continue to boil for 10 minutes, pour off water, and place coated aggregate on a paper towel.

5) Perform a visual inspection to verify that the coated aggregate shows no evidence of stripping.

3. **Test for Percent Loss on Ignition (LOI) of the Mineral Aggregate in an Asphalt Paving Mixture**. Conduct Loss on Ignition Testing as follows:

a. Obtain a representative aggregate sample and weigh approximately 600 grams into an assayer's fire clay crucible that has been ignited to constant weight. Place a cover on the crucible to prevent pop-out of aggregate while heating.

b. Ignite the covered crucible and its contents in a muffle furnace at 1742° F to constant weight (minimum of 8 hours).

c. Cool the crucible and contents to room temperature and weigh.

If the aggregate sample is obtained by extraction with a vacuum extractor, correct the weights before and after ignition for filter aid using the following equation:

$$\text{Percent loss on ignition} = \frac{(A - B) \times 100}{A}$$

Where:

A = weight of sample before ignition (corrected for filter aid)
B = weight of sample after ignition (corrected for filter aid)

EQUIPMENT

407.04 Bituminous Mixing Plant

Provide sufficient storage space for each size aggregate. Keep the different sizes separated until they have been delivered to the cold elevator or belt feeding the dryer. Maintain the storage yard in a neat and orderly condition and ensure that the separate stockpiles are readily accessible for sampling.

Plants used to prepare bituminous mixture shall meet all requirements specified in **407.04.A**. In addition, batch mixing plants shall meet **407.04.B**, continuous mixing plants shall meet **407.04.C**, and dryer-drum mixing plants shall meet **407.04.D**.

A. Requirements for All Plants

Mixing plants shall be of sufficient capacity and so coordinated to adequately handle the proposed bituminous construction.

1. **Equipment for Preparing Bituminous Material.** Provide tanks that are equipped to heat and hold bituminous material at the required temperatures. The circulating system for the bituminous material shall be designed to ensure proper and continuous circulation during the operating period. Make provisions for measuring and sampling the storage tanks' contents.

2. **Feeders for Dryer.** For each size aggregate, provide separate feeders that can deliver the aggregates onto the belt going to the dryer in proper proportions. Use mechanical feeders with separate adjustable gates to feed each size aggregate onto the belt.

   Provide adequate means to ensure a constant and uniform flow of material from each bin. Equip bins containing fine aggregate with vibrators if necessary.

   Do not blend or mix different aggregates, or different sizes of the same aggregates, with clam shells, bulldozers, high lifts, or similar equipment.

   Feed the aggregate into the dryer to obtain a uniform production and uniform temperature.

3. **Dryer.** The plant shall include a dryer or dryers that are capable of:

   a. agitating the aggregate continuously during the heating and drying process;

   b. heating and drying all aggregates to the temperature required; and

   c. supplying the mixing unit continuously at its operating capacity.

   Ensure that dryers are constructed and operated so that aggregates will not be contaminated with unburned fuel.

4. **Screens.** Provide plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the mixer's full capacity.

   The Contractor may allow a consistent carry-over, not to exceed 20%, on any screen. If any bin contains more than 20% of material that is undersized for that bin, empty the bin and correct the cause of this condition.

   Provide approved scalping screens on all dryer-drum mixing plants; additional screens will not be required.

5. **Bins.** Provide storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Arrange bins to ensure separate and adequate storage of appropriate fractions of the mineral aggregates. For each bin, provide overflow pipes of the size and at the location needed to prevent material from backing up into other compartments or bins. Provide each compartment with an outlet gate constructed so that, when closed, no leakage occurs. The gates shall be cut off quickly and completely. The bins shall be constructed to provide adequate and convenient approved facilities for obtaining representative samples of aggregate from the full flow of each compartment. These bins are not required in an approved Dryer-Drum Mixing Plant. When using mineral filler, provide separate dry storage and equip the plant to uniformly and accurately feed the filler into the mixer.

6. **Bituminous Control Unit and Anti-Stripping Additive (ASA) Systems.** Provide means for weighing or metering the bituminous

material to ensure the proper amount of material is added to the mix within the tolerance specified. Provide means for checking the quantity or rate of flow of bituminous material into the mixer.

Where required, use approved in-line blending equipment to add anti-stripping additive, other than hydrated lime, meeting **921.06.B**. Provide a storage tank for the ASA that can maintain a constant temperature without overheating the additive. Store the additive according to the manufacturer's recommendations and at a temperature of 150 ºF or less. The in-line blending equipment on drum plants shall have a totalizing "flow meter" capable of measuring the actual flow rate within the production range of 0.00 to 1.00 gallons per minute at increments of 0.05 gallons. Batch plants shall have a totalizing flow meter that displays the total gallons of material dispensed. The dispenser and/or pumps shall be capable of adding the heat stable ASA within a tolerance of 10% of the specified rate.

7. **Thermometric Equipment.** Fix an armored thermometer, capable of reading an adequate temperature range, in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

   At the discharge chute of the dryer, also place an approved thermometric instrument that can register automatically or indicate the temperature of the heated aggregates. With the Engineer's approval, the Contractor may place the thermometric instrument within the fines bin.

   Equip the plant with an approved automatic recording and regulating apparatus to control the temperature of the aggregates.

8. **Dust Collector.** Equip the plant with a dust collector constructed to uniformly waste or return to the dried aggregate all or any part of the material collected. Handle collected baghouse fines intended for recirculation into the mix as if it were mineral filler or feed by another suitable method approved by the Engineer. Provide means to calibrate and adjust the dust fed from a baghouse.

9. **Safety Requirements.** Provide adequate and safe stairways to the mixer platform and sampling points. Place guarded ladders to other plant units at all points requiring access to plant operations. Provide access to the top of truck bodies by a platform or other suitable device to allow the Engineer to obtain samples and mixture

temperature data. Provide a hoist or pulley system to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return. Guard and protect all gears, pulleys, chains, sprockets, and other dangerous moving parts. Provide ample and unobstructed space on the mixing platform. Maintain a clear and unobstructed passage at all times in and around the truck loading area. Keep this area free of drippings from the mixing platform.

10. **Field Laboratory.** Provide a Type B field laboratory as specified in **106.06**.

11. **Surge and Storage Systems.** The Contractor may use surge and storage systems if the Department approves each system before use, and if the systems are designed to limit differences between material discharged from the bin or silo and material discharged directly from the plant.

    Equip the surge bins and storage silos with low and high mix level indicators. Place the low level indicator at a location on the bin or silo that has been predetermined to prevent segregation of the mix.

    Arrange the conveyor system used with the surge bins or storage silos so that samples of the mix or dry material may be conveniently taken.

    Ensure that storage silos are closed, insulated, and heated to prevent localized heating. The storage silo shall be capable of being sealed to prevent oxidation of the mixture. Equip surge bins with a rain cover capable of preventing water from entering the mix in the bin.

    The Engineer will base approval of a surge or storage system on inspection and tests that indicate that the system is capable of conveying, retaining, and delivering the bituminous mixture:

    a. Within the tolerance ranges as set forth on the JMF;

    b. Without segregation; and

    c. Without balling or hardening.

The Engineer may withdraw approval of a surge or storage system if tests, inspections, or both indicate that the system is having a detrimental effect on the bituminous mixture.

The Engineer will reject bituminous mix found to be damaged in any way by the use of a surge or storage system.

Mount, under the loading hopper, platform truck scales that meet the requirements of **109** and that are capable of recording tare and gross weights.

12. **Warm Mix Asphalt Process Equipment.** The Contractor may modify plants to reduce production and placement temperatures as specified in **407.11.B**. Obtain the Department's approval before making plant modifications for warm mix asphalt production temperatures. Modifications shall not impair the plant's ability to maintain temperature control or mixture proportions.

    Ensure that modifications made to the plant to reduce mixing temperatures meet the requirements listed for warm mix asphalt additives in the Department's Qualified Products List (QPL).

B. Requirements for Batching Plants

1. **Plant Scales.** Provide dial scales for weighing of all aggregates and mineral filler, in the suspended weigh box. Dial scales shall be of a standard make and of sufficient size to allow the numerals on the dial to be read at a distance of 25 feet. The dials shall be of the compounding type having a full complement of index pointers. The value of the graduation of scales shall be as specified in Table 407.04-1.

Table 407.04-1: Graduation of Scales

Aggregate Amount (pounds)	Scale Graduation
< 5,000	≤ 5 pounds
5,000 to 10,000	≤ 10 pounds
> 10,000	≤ 0.1% scale capacity

Do not use pointers that give excessive parallax errors. Locate dial scales to be in plain view of the operator at all times. When

bituminous material is measured by weight, equip the asphalt weigh bucket with a separate dial scale with a minimum graduation not greater than 2 pounds. All dial scales shall be accurate within a tolerance of 0.5%. Eliminate vibration by setting the scales on a separate foundation, if required. Provide each installation of scales with ten standard 50-pound weights meeting the requirements of the U.S. Bureau of Standards for calibrating and testing weighing equipment. Inspect scales as often as the Engineer deems necessary to ensure their continued accuracy.

Provide an approved automatic printer system that will print the weights of the material delivered, when the system is used in conjunction with an approved automatic batching and mixing control system. Provide a weigh ticket for each load as evidence of such weights.

2. **Weigh Box or Hopper.** Provide means for accurately weighing each size of aggregate and mineral filler in a weigh box or hopper suspended on scales. The weigh box or hopper shall be of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material can leak into the mixer while a batch is being weighed.

3. **Bituminous Control.** Provide a bituminous material bucket of a non-tilting type. The length of the discharge opening or spray bar shall be not less than ¾ the length of the mixer, and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drainable and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15% in excess of the weight of bituminous material required in any batch. Provide the plant with an adequately heated, quick-acting, non-drip, charging valve located directly over the bituminous material bucket. If the bituminous material is metered, the indicator dial shall have a capacity of at least 15% in excess of the quantity of bituminous material used in a batch. The meter indicator dial shall have a scale with divisions measuring in gallons equivalent to a weight sensitivity of 0.04% of the total batch weight. The meter shall be accurate within a tolerance of 0.5%. The controls shall be capable of being locked at any dial setting and automatically resetting to that reading after the addition of bituminous material to each batch. The

dial shall be in full view of the mixer operator. Automatically control the flow of bituminous material so that it will begin when the dry-mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. Provide the section of the bituminous line between the charging valve and the spray bar with a valve, and provide the spray bar with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

4. **Mixer.** Provide an approved twin pugmill type mixer, steam or hot oil jacketed, that is capable of producing a uniform mixture within the job mix tolerances and that is constructed to prevent leakage of its contents. Equip the mixer with a sufficient number of paddles or blades set in the "run around" order, and operate at such speed as to produce a properly and uniformly mixed batch. The depth of the material in the pugmill shall not be above the tips of the paddles. If not enclosed, equip the mixer box with a dust hood to prevent loss of dust.

   The clearance of blades from all fixed and moving parts shall not exceed 1 inch unless the maximum diameter of the aggregate in the mix exceeds 1-1/4 inches, in which case the clearance shall not exceed 1-1/2 inches.

5. **Control of Mixing Time.** Equip the mixer with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate, at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry-mixing period and shall lock the mixer gate throughout the dry and wet-mixing periods. The dry-mixing period is defined as the time interval between the opening of the weigh box gate and the start of introduction of bituminous material. The wet-mixing period is the time interval between the start of introduction of bituminous material and the opening of the mixer gate. The control of the timing shall be flexible and capable of being set at intervals of 5 seconds or less throughout a total cycle of up to 3 minutes. As a part of the timing device, install a mechanical batch counter that is designed to register only batches that have been mixed for the full time interval. Set the time intervals in the presence of and at the direction of the

Engineer, who will then lock the case covering the timing device until a change is needed in the timing periods.

6. **Operator's Platform Observation House.** Equip the plant with a scale observer's house, mounted on or near the weigh platform and situated so that the aggregate and asphalt scales, asphalt thermometer, and pyrometer are plainly visible from within the house.

   Using approved materials, soundly construct the house to have at least 45 square feet of floor space and to be air conditioned by a unit of at least 12,000 Btu. The Contractor may install all batch controls in the house. However, do not use the house for storage or purposes other than to house the batch controls, plant operator, and Department Inspector. If choosing not to move the plant controls into the house, situate it to provide the scale inspector with a full view of the control panel.

   If the scale-observer's house is located on the asphalt plant, provide an adequate secondary means of escape in the event of fire or explosion.

   The Department will consider the house to be part of the plant and will not directly pay for its construction and maintenance.

C. Requirements for Continuous Mixing Plants

1. **Aggregate Proportioning.** Provide the plant with means for accurately proportioning each size of aggregate. The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for measuring volumetrically the material drawn from each compartment. Equip bins with adequate tell-tale devices to indicate the position of the aggregates in the bins at the lower quarter points.

   The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means provided with a lock. Provide indicators for each gate to show the respective gate opening in inches.

Ensure that mineral filler can be fed into the mixer continuously and uniformly in the proportion set out in the JMF, and in a manner satisfactory to the Engineer.

2. **Weight Calibration of Aggregate Feed.** Equip the plant with an approved revolution counter that is in satisfactory working condition. Provide means to calibrate gate openings by weighing test samples. Make provisions so that materials fed out of individual orifices may be bypassed to individual test boxes. Equip the plants to handle individual test samples weighing not less than 200 pounds. Provide accurate scales to weigh such test samples.

3. **Synchronization of Aggregate Feed and Bituminous Material Feed.** Provide positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control may be achieved using mechanical means or any other positive method satisfactory to the Engineer.

4. **Mixer.** Provide a continuous mixer of an approved twin pugmill type, which is adequately heated and capable of producing a uniform mixture within the job mix tolerances. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate indicating the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Provide charts showing the rate of feed of aggregate per minute for the aggregate being used. Determine the mixing time by the weight method, using the following formula (with weights determined for the job using tests conducted by the Engineer) where:

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

5. **Surge Hopper.** Equip the mixer with a discharge hopper with dump gates that will allow rapid and complete discharge of the mixture and of such size and design that no segregation of the mixture occurs.

6. **Platform Truck Scales.** Platform truck scales shall meet the requirements of **109**.

D. Requirements for Dryer-Drum Mixing Plants

1. **Control of Aggregate.** Stockpile and handle aggregates to prevent any significant amount of segregation, contamination, or degradation. Construct stockpiles as specified in **903.20**.

   Each aggregate shall have a separate feeder with a positive feed that can be easily and accurately calibrated. Provide a flow indicator and an audible warning device on each separate feeder to ensure a constant and uniform flow of aggregate from each bin onto the belt.

   Feed mineral filler, if required, into the mixer continuously and uniformly in the proportion set out in the JMF and in a manner approved by the Engineer.

2. **Synchronization of Aggregate Feed and Bituminous Material Feed.** Provide satisfactory means to allow a positive interlocking control between cold aggregate feed and asphalt. Base the control setting for the asphalt flow on the dry weight of the aggregate. Provide an acceptable method for proportioning asphalt flow as variations in aggregate flow take place. Provide a metering system to measure the flow of asphalt into the drum, and locate an approved method of checking and calibrating the metering system in the control house. Provide an automatic interlock system that will shut off the asphalt flow and the burner when the aggregate flow ceases.

3. **Temperature Control.** Provide dryer-drum mixing plants equipped with a recording pyrometer or other approved thermometric instrument sensitive to a rate of temperature change of not less than 10 °F per minute. The system shall be equipped with automatic burner controls and shall provide for temperature sensing of the bituminous mixture at discharge from the drum.

4. **Scales and Metering Systems.** Provide weights and charts for checking the accuracy of the belt scales and the bituminous metering system. The scales and meters shall be accurate within a tolerance of 0.5%.

   The belt scale that weighs the combined aggregate shall be in accordance with the National Institute of Standards and Technology Handbook 44.

5. **Sampling Devices.** Use an approved method for sampling individual cold feeds and sequential sampling of aggregate and asphalt under full scale production. The sampling device and procedures used shall be approved by the Engineer and shall not interrupt normal operation.

6. **Platform Scales.** Make certified platform scales available for checking the asphalt metering system and for weighing or checking loads of asphalt mix as specified in **109**.

7. **Silos or Surge Bins.** Provide surge bins or storage silos as specified in **407.04.A.11**. If a silo is not provided, use an approved surge bin capable of holding sufficient mix to allow the plant to operate at an efficient rate of production, and ensure the system is capable of conveying, retaining, and delivering the bituminous mixture so that it is within the JMF and without segregation. The Engineer will reject mix that is damaged in any way.

   The surge bin may include an approved weighing system. If a weighing system is included in the surge system, provide approved weights for checking the weighing system. Check the system in maximum increments of 5,000 pounds and in a minimum of 3 increments. Check the system through its entire weighing range to or above the maximum weight that is expected to be applied. The system shall be accurate within a tolerance of 0.5%.

   For surge bins that do not include a weighing system, mount platform truck scales meeting the requirements of **109** under the loading hopper.

8. **Aggregate Feed.** Proportion aggregate by feeding each size aggregate from a separate cold bin. The belt that delivers the aggregate shall have a load cell capable of registering the amount of flow from each individual bin on a readout in the control office; alternatively, the Contractor may proportion the aggregate by a linear system based on measured RPM of each feeder belt at a constant gate opening to feed aggregate at a predetermined rate that is set in the control office and that has a readout in the control office. Ensure that the rate of feed as determined from the bin settings agrees with the load cell on the collection belt feeding the dryer within a tolerance of plus or minus 10%. If the predetermined tolerance is exceeded, an alarm shall sound, and if corrections are not made within 60 seconds, the plant shall automatically shut down.

The aggregate feed system shall employ computer controlled adjustments to automatically produce mix of the correct proportions over the plant's entire range of production rates.

If the Engineer has previously calibrated and approved the plant for temporary manual operation, the plant may run for a period not to exceed 2 working days, or portions thereof, on manual should a computer breakdown occur.

9. **Electronic Data Retention.** The computer system and automatic weighing system shall include means to retain all electronic data during electrical power failures.

407.05 Hauling Equipment

Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds that have been thinly coated with a minimum amount of paraffin oil, hydrated-lime solution, or other approved material from the Department's QPL to prevent the mixture from adhering to the beds. Immediately after loading at the plant, cover each truck with a cover of canvas or other suitable material that is of sufficient size to protect the mixture from the weather. Allow the cover to lap down along the sides and rear of the truck bed a minimum of 6 inches, and use tie downs to secure the cover at a maximum of 5-foot spacing along the sides and rear of the truck bed. When necessary to ensure the mixture will be delivered on the road at the specified temperature, insulate truck beds and securely fasten the covers. Provide a 3/8-inch hole in both sides of each truck bed for inserting a thermometer.

407.06 Bituminous Pavers and Material Transfer Devices

A. Pavers

Bituminous pavers shall be self-contained, power-propelled units provided with an activated screed, equipped to be heated, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thickness shown on the Plans. All screed extensions shall be full assembly extensions, including activated and heated screeds. Pavers shall include throw-back blades, reverse augers, or equivalent to place mix beneath the auger gearbox. Auger extensions shall be incorporated in a manner such that the maximum distance from the augers to the end plate shall be 18 inches. Screed extensions may extend beyond the 18-inch maximum from auger extensions only when extending for short-term temporary deviations in

pavement width such as driveways. Do not use strike-off boxes, with the exception of sections with continuously varying width.

Equip the paver with a receiving hopper that has sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

Equip all asphalt paving machines with automatic grade and slope controls. Both the grade and slope controls shall be in working order at all times; however, if the automatic controls fail, the Contractor may finish the day's work using manual controls, but shall not resume work the following day until both the grade and slope controls are in first class working order.

The Engineer may allow the Contractor to pave the inside shoulder concurrently with the inside traffic lane, subject to the Engineer's approval of the price adjustment for the mix used on the shoulder and of the paving and rolling equipment. In addition, the paver shall have an articulated screed that can be adjusted to fit the pavement cross-section and a power unit capable of handling the increased loading without undue stress.

B. Material Transfer Devices (MTDs)

Provide a Material Transfer Device (MTD) capable of transferring the asphalt from the truck or trailer to the asphalt paver without coming in contact with the asphalt paver. Use a MTD when placing all asphalt mixes, including shoulder mixes, with the exception that it will not be required when placing CS mix. An exception may be allowed due to lane width or safety issues if approved by the Engineer.

The MTD shall have a minimum storage capacity of 15 tons, and shall be equipped with mixing augers in the bottom of the storage hopper that are capable of remixing or re-blending the material as the material is removed from the storage hopper. The mixing augers shall be operational and used at all times during placement of the asphalt mixes. The MTD shall have a rear discharge conveyor that swivels a minimum of 150 degrees to allow feeding the paving machine from the front, side or rear.

Insert a stationary surge hopper into the paving hopper of the paver being fed by the MTD. The stationary surge hopper shall be considered as part of the MTD and shall have sloping sides (minimum of 60 degrees from horizontal) and a minimum storage capacity of 15 tons.

Obtain the Department's approval of models and manufacturers of MTDs before using on the Project. The Department will make no direct payment for use of an MTD and will consider all cost of furnishing and operating the MTD as incidental to the work.

407.07 Rollers

Provide self-propelled rollers, of steel-wheel, pneumatic tire, and/or vibratory type, which are in good condition and capable of reversing without backlash. Operate rollers at speeds slow enough to avoid displacement of the bituminous mixture. Equip rollers with a device for moistening and cleaning the wheels as required.

The required rollers shall be on the job, inspected, and approved before the start of paving operations.

Rollers shall meet the following additional requirements:

1. The steel-wheel roller shall weigh a minimum of 8 tons and may be either a three wheel or tandem type.

2. The pneumatic tire rollers shall have a minimum contact pressure of 85 pounds per square inch. The roller shall contain two axles upon which at least seven pneumatic-tire wheels are mounted to ensure the rear set of tires will not track the front set. The axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Uniformly inflate the tires. Provide the Engineer with charts or tabulations of the contact area and contact pressures for the full range of tire inflation pressures and loadings for each size of roller tire provided. In place of a pneumatic tire roller, the Contractor may substitute a combination roller (pneumatic and steel wheel combination) of the make and model approved by the Department.

3. The Contractor may use vibratory rollers if the Engineer approves the particular roller proposed for use.

When paving the inside shoulder concurrently with the inside traffic lane, provide an additional roller, having a minimum width of 4 feet to a maximum width of 1 foot wider than the inside shoulder being paved, to compact the shoulder. Do not allow either the roller(s) on the inside traffic lane or the roller on the shoulder to traverse between the inside shoulder and the inside traffic lane.

407.08 Small Tools

Provide all necessary small tools, and keep them clean and free from accumulations of bituminous materials.

CONSTRUCTION REQUIREMENTS

407.09 Weather Limitations

The Contractor may place bituminous plant mix on properly constructed and accepted subgrade or previously applied layers if:

1. The subgrade and the surface upon which the bituminous plant mix is to be placed is free of excessive moisture, and

2. The bituminous plant mix is placed according to the temperature limitations specified in Table 407.09-1 and when weather conditions otherwise allow the pavement to be properly placed, compacted, and finished.

Table 407.09-1: Temperature Limitations

Compacted Thickness	Minimum Air or Surface Temperature (°F)	
	Unmodified mixes (PG 64, 67)	Modified mixes (PG 70, 76, 82)
≤ 1.5 inches	45	55
> 1.5 inches to < 3.0 inches	40	50
≥ 3.0 inches	35	45

3. Do not place bituminous plant mix, with a compacted thickness of 1.5 inches or less, between November 30 and April 1. Do not place

bituminous plant mix, with a compacted thickness greater than 1.5 inches, between December 15 and March 16. Only place 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures when the pavement surface temperature and the ambient air temperature are a minimum of 55 °F and rising; limit placement to the period from April 1 to November 1. If the temperature meets the above requirements, outside of normal paving season, a request for a seasonal limitation waiver may be submitted for Departmental consideration. Requests shall be submitted in writing at least one week before the anticipated need.

4. If determined necessary by the Department, the Contractor may request a variance from the above required temperatures and seasonal limitations to pave at lower temperatures by submitting a Cold Weather Paving and Compaction Plan. All projects requiring a Cold Weather Paving and Compaction Plan shall utilize Intelligent Compaction to demonstrate proper coverage and compaction temperature at no additional cost to the Department; with the exception of small quantity projects, such as, but not limited to, bridge approaches, intersections, and temporary traffic shifts. Upon completion, the documentation showing appropriate coverage and compaction temperature shall be provided to the Department. Submit requests in writing at least one week before the anticipated need, and include a Cold Weather Paving and Compaction Plan that meets the Department's Procedure. The plan shall identify what practices and precautions the Contractor intends to use to ensure the mixture is placed and compacted to meet the specifications. The plan shall include compaction cooling curves estimating the time available for compaction, the intended production, haul, and compaction rates, with paver and roller speeds estimated. The Contractor may consider using such practices as the addition of rollers, reduced production and paving rates, insulated truck beds, and heating the existing surface.

   In no cases will a Cold Weather Paving and Compaction Plan or seasonal limitation waiver be approved for 411-OGFC, 411-TL, 411-TLD, or 411-TLE.

   If the specified densities are not obtained, stop all paving operations and develop a new plan. All mixture failing to meet specifications will be subject to price adjustments or removal and replacement at no cost to the Department.

407.10 Conditioning the Existing Surface

If bituminous mixes are to be placed upon an existing concrete pavement, with or without a bituminous overlay, remove all excess bituminous material from joints and cracks. Remove sections of existing pavement that are broken and pumping under traffic. Remove pavement where blowups have occurred at joints or cracks to provide a minimum opening of 1 foot for the full width of the pavement.

If the bituminous mixture is to be placed upon an existing bituminous pavement, remove areas containing excess bitumen and failures in the existing surface and base as directed by the Engineer.

Adjust all manholes and catch basin frames, which are associated with the storm sewer system, to the finished grades of the pavement. Unless otherwise specified, make such adjustments at no additional cost to the Department. The respective Utility Owner(s) will properly adjust all utility manholes, utility valve covers, and similar structures, to the finished grades of the pavement, unless otherwise shown on the Plans.

Remove unsatisfactory subgrade material encountered when removing the existing pavement and replace with approved material. Use overlay mixture or other approved material to fill openings left by the pavement and base removal to the full depth of the existing pavement, as directed by the Engineer, and compact the material in layers not to exceed 3 inches in thickness.

Paint contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of bituminous material before placing the mixture against them.

When shown on the Plans, bring existing surfaces that are warped and irregular to uniform grade and cross-section using the leveling mixture specified in **307**.

407.11 Preparing the Bituminous Material

A. Hot Mix Asphalt (HMA)

Heat the bituminous materials for hot mixes to the required mixing temperature specified in Table 407.11-1.

Table 407.11-1: Mixing Temperatures

PG Binder Grade	Minimum Temperature (°F)	Maximum Temperature (°F)
PG 64-22, PG 67-22	270	310
PG 70-22	290	330
PG 76-22	290	330
PG82-22	290	330

Minimum temperature for OGFC mixes shall be 280º.

The temperature for Grading AS, Grading ACRL, and Grading TPB mixtures shall be between 225 and 275 °F, except when modified binders are used, and then the temperatures shall be between 250 and 310 °F. Aggregate should be coated, and no visible drain down should occur in storage silos or hauling equipment.

B. Warm Mix Asphalt (WMA)

The Contractor may subject the produced mixture to reduced production and placement temperatures by adding a chemical warm mix additive meeting **921.06.B.3** or by making plant modifications as specified in **407.04.A.12.**

When using either WMA technology, the maximum mixing temperature for any grade of asphalt cement shall be no more than 300 °F. At the beginning of a day's production, the producer may produce up to five truckloads at the temperatures specified in Table 407.11-1 to pre-heat placement equipment (pavers, transfer devices) before producing WMA. Indicate the laboratory mixing and compaction temperatures on the JMF during the mix design approval process. A tolerance of plus or minus 5.0 °F for each temperature will be allowed.

During test strip construction, ensure that all plant-produced WMA exhibits the ability to meet the test requirements for tensile strength ratio (TSR), conditioned tensile strength, Marshall Stability and flow, volumetrics, and boil test, as specified for HMA in specifications **307**, **407**, and **411**. Procedures for testing shall be in accordance with that which is defined for quality control and acceptance in **407.03.D.2.h** and **407.20.B.3**, respectively.

407.12 Preparation of Aggregates

Unless otherwise specified, dry and heat the aggregate for hot mixes to produce a completed mix of a uniform temperature as specified in Table 407.11-1. Adjust flames used for drying and heating to avoid damage to the aggregate and to avoid soot on the aggregate.

On all plants requiring screens, screen the hot dried aggregate into two or more fractions as specified. Convey the separated fractions into separate compartments ready for batching and mixing with bituminous material.

407.13 Mixing

Combine the dried aggregates within the mixer in the amount of each fraction of aggregates required to meet the JMF. Measure the bituminous material and introduce it into the mixer in the amount specified by the JMF.

After introducing the required amounts of aggregate and bituminous material into the mixer, mix the materials as long as necessary to obtain a complete and uniform coating of the particles and a thorough distribution of the bituminous material. The Engineer will determine wet-mixing time for each plant and for each type of aggregate used, but in no case shall the wet-mixing time be less than 25 seconds for batch type plants and 40 seconds for continuous mix plants.

The temperature of the completed mixture (determined at the time it is dumped from the mixer), made with aggregates containing absorbed moisture that causes foaming or boiling in the completed mix, shall be not less than 225 °F. The temperature of the mix when it is discharged from the mixer shall not deviate from that specified in **407.11.A**.

The Contractor may place hot-mixed bituminous mixtures in surge or storage silos if the mixture as used from the silos meets all the specification requirements for the particular mix involved.

When using surge or storage silos, as approved by the Engineer, meet the following additional requirements:

1. Provide a surge bin or storage silo system meeting **407.04.A.11**.

2. Empty the storage silos or surge bins when directed by the Engineer to check material quantities.

3. Limit hours of plant operation, whether for storage or direct shipment to the road, to reasonable working hours to allow normal inspection of plant operations.

4. Remove bituminous mixtures placed in a surge bin on the same day in which it is stored.

5. The Contractor may store bituminous mixtures of Gradings A, AS, ACRL, and B for up to 48 hours, and Gradings BM, BM2, C, CS, CW, D, E, and F for up to 96 hours, in a storage silo by complying with the following:

   (a) Add an approved silicone additive to the asphalt cement for mixes to be stored beyond the day of mixing.

   (b) Keep the stored bituminous mixture sealed at all times during storage.

   (c) Fill the storage silo to at least 90% of capacity.

6. The Inspector will take samples of the stored material following the period of storage.

7. The stored material is subject to the same temperature, segregation, and laying requirements as required for unstored plant production.

8. The Engineer will reject mixtures having excessive segregation, lumpiness, or stiffness.

9. Locate the surge bins and storage silos in a position that enables the top of the truckload to be visible to the load operator during the loading operation.

407.14 Spreading and Finishing

For Contracts requiring night work, supply sufficient lighting and equipment as specified in **712.04.H**.

The temperature of the mixture at the time of depositing in the paver hopper shall be as specified in Table 407.11-1.

Place the mixture upon an approved surface, and spread and strike-off to the established lift thickness, line, grade, and elevation using approved asphalt paving machine(s). The Engineer may approve use of echelon or full-width paving if plant production is capable of supplying the paver so that a constant forward speed can be maintained. Use preset control string lines to control the alignment of the outside edge of the pavement. Where multi-course pavements are placed, offset the longitudinal joint in one layer from that in preceding layer by approximately 1 foot; however, construct the joint in the top layer at the centerline of the pavement if the roadway comprises two lane widths, or at lane lines if the roadway is more than two lanes in width. Pave in the direction of traffic.

Do not feed a paving machine from more than one asphalt plant. Coordinate plant production and paving operations to ensure constant forward movement of the pavers. The Engineer will consider repetitive interruptions or stopping of the paver as cause for stopping the work until the Contractor corrects the situation. If the paver must be stopped for a significant period of time, construct a joint and move the paver from the roadway before the bituminous mixture has cooled sufficiently to prevent proper compaction. If the bituminous mixture cools to the extent that the required density cannot be obtained, remove and replace the mixture at no cost to the Department.

Unevenness of texture, segregation (including end-of-load segregation) or tearing or shoving of bituminous mixture during the paving operation, shall be reason to stop the paving. Only resume paving operations when the condition is corrected. Immediately remove unacceptable mix and replace at no cost to the Department. The Department will not allow excessive throwing back of the bituminous mixture. Any amount of mixture not fully adhered to the roadway shall be repaired prior to completion of the project. If the failure is not repaired the same day as originally placed, the method of repair must be approved by the Engineer prior to beginning of the repair. The repairs will be no additional cost to the Department.

Provide automatic screed controls using either the string line, ski type grade reference system, or a non-contact averaging system on all work regardless of the paver width. The Engineer may require a string line reference system on new construction. If the base has been finished with equipment having automatic grade control or the Contractor demonstrates that an alternate method of spreading and finishing will result in a satisfactory riding surface, the Engineer may conditionally waive the string line requirement and authorize use of the ski type reference system. Regardless, the Engineer may at any time require the use of a string line reference system, even if previously waived, if in the Engineer’s opinion, the use of the string line will result in a

superior riding surface. When the string line system is required on a multi-course pavement, use it on at least two courses exclusive of the surface course. When using the ski type system, the ski shall have the maximum practical length and in no case shall it be less than 40 feet in length. Pavement lanes previously placed with automatic controls or to form grade may serve as the longitudinal control reference for placing adjacent lanes by using a ski or joint matching shoe.

The string line reference system shall consist of suitable wire or twine supported by approved devices that are compatible with the type of automatic paver control system used. The string line and supports shall be capable of maintaining the line and grade shown on the Plans at the point of support while withstanding the tensioning necessary to prevent sag in excess of ¼ inches between supports spaced 50 feet apart. Install additional supports to provide a minimum spacing of 25 feet, or less as directed by the Engineer, to remove the apparent deviation of the string line from theoretical grade.

Provide all materials, equipment, labor, and incidentals necessary to construct the string line reference system, and maintain the system until its use is no longer required. Include the cost of erecting and maintaining the string line reference system in the unit price bid for other items of construction. Have the string line reference system be complete in place at least 300 feet in advance of the point where the pavement is being placed. Automatic screed controls are not required on sections of projects where service connections and other conditions interfere with their efficient operation.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, take the mixture from the hopper of the spreading machine and distribute it immediately into place using suitable shovels and other tools, and spread the mixture with rakes and lutes in a uniformly loose layer of such depth as will result in a completed course having the required thickness.

The Contractor and the Department will each be required to have an individual onsite that is certified by the Department through the HMA Roadway Certification Course.

407.15 Compaction

A. General

After spreading and striking-off the bituminous mixture and adjusting surface irregularities, thoroughly compact the mixture using methods

approved by the Engineer and that are capable of achieving the specified density while the material is in a workable condition. When no density requirements are specified, use a system of compaction for roadway pavements that has previously produced the required bituminous pavement densities. The Engineer may require a control strip and random density samples to evaluate the system.

In general, accomplish compaction using a combination of the equipment specified in **407.07**. As a minimum, meet the roller requirements in Table 407.15, but increase the number of rollers if the required results are not being obtained.

Table 407.15 – Roller Requirements by Mix Type

Mix Type	Roller Requirements
307-A, 307-B, 307-BM-2, 307-C, 307-CW (except surface)	3 Rollers (Intermediate roller shall be Pneumatic)
307-AS, 307-ACRL, 411-D, 411-E, 307-CW (surface), 313-Asphalt Treated Permeable Base	3 Rollers (unspecified)
411-TL, 411-TLD, 411-TLE, 307-CS (when paved as a continuous layer)	2 Rollers (unspecified)
411-OGFC	2 Rollers (both rollers shall be static steel double drum, 10 Ton minimum
Any mix used for scratch paving	2 Rollers (breakdown shall be pneumatic)

1. If the compaction effort is detrimental to the quality of the mat, immediately stop and re-evaluate rolling patterns and equipment. To modify the roller train from that which is specified for the mix, submit to the engineer a written request of the rollers to be substituted and a narrative explanation of how the specified equipment has been detrimental to the quality of the pavement.

2. The Department will only consider requests for substitution of equipment when it is shown that best practices are being followed and that the problem is not due to improper operation or poor maintenance of the equipment. If this request is approved by the Engineer, a new test strip and roller pattern shall be established.

3. With the Engineer's approval, the Contractor may reduce the minimum number of rollers listed above to one roller of either the

steel-wheel or vibratory type on the following types of construction and projects:

a. Shoulder construction,

b. Incidental construction such as bridge approaches and driveways, and

c. Projects containing less than 1,000 tons of bituminous pavement.

4. Compaction of 411-OGFC mixtures shall consist of a minimum of two passes before the material temperature has fallen below 185 °F. Unless otherwise directed by the Engineer, begin rolling at the low side and proceed longitudinally parallel to the road centerline. When paving in echelon, or abutting a previously placed lane, roll the longitudinal joint first, followed by the regular rolling procedure. When paving in echelon, rollers shall not compact within 6 inches of an edge where an adjacent lane is to be placed. Operate rollers at a slow uniform speed with the drive wheels nearer the paver, and keep the rollers as nearly as possible in continuous operation. Continue rolling until all roller marks are eliminated. Do not park rollers on the bituminous pavement.

To prevent adhesion of the mixture to the rollers, keep the wheels properly moistened with water or water mixed with very small quantities of detergent or other approved material. Limit excess use of liquid.

Do not refuel rollers on bituminous pavements.

Along forms, curbs, headers, walls and other places not accessible to the rollers, compact the mixture thoroughly using hot hand tampers, smoothing irons, or with mechanical tampers. On depressed areas, the Contractor may use a trench roller to compact the mix.

B. Density Requirements

Meet the applicable density requirements specified in Table 407.15-1.

Table 407.15-1: Density Requirements for Bituminous Pavement

Mix Type	% of Maximum Theoretical Density (Lot Average)	No Single Test Less Than, % (Sub Lot)
Travel Lanes ADT <1,000 A, B, BM, BM-2, C, CW, D, E	90.0	87.0
Travel Lanes 1,000 <ADT <3,000 A, B, BM, BM-2, C, CW, D, E	91.0	89.0
Travel Lanes ADT >3,000 A, B, BM, BM-2, C, CW, D, E	92.0	90.0
Travel Lanes and Shoulders Any ADT CS, TL, TLD, TLE, OGFC	NA	NA
Shoulders B, BM, BM-2, D, E	88.0	85.0

Correct sublots that test below the minimum density so that the density of the area is equal to or above the minimum, at which point it can be used to determine the average density of the lot. Do not place any successive layers until the area has been corrected. As necessary to determine the classification of open graded or dense graded mixes and to measure segregation, use AASHTO T 269 or ASTM D3203.

Repair or replace defective mixture to the satisfaction of the Engineer and at no cost to the Department.

The Department will perform density testing in accordance with **407.20.B.5**.

C. Test Strips

Construct test strips for all A, B, BM, BM-2, C, CW, D, and E mixes to establish rolling patterns, to accommodate the Department to calibrate nuclear gauges, to verify that the base course or surface course mixture meets the density requirements of the specifications, and for mix design

and production verification as required. A test strip is not required for mixes AS, A-CRL, CS, TL, TLD, and TLE, but adjustments to the roller pattern may be made at the direction of the Engineer.

Before constructing the test strip, obtain the Engineer's approval of the underlying base or other pavement course. Compact the test strip using equipment as specified in this subsection and **407.07**.

Construct the test strip at the beginning of work on the pavement course. Prepare new test strips when:

1. A change in the JMF is necessary;

2. A change in the source of materials occurs;

3. A change in the material from the same source is observed;

4. There is reason to believe that the test strip density is not representative of the bituminous mixture being placed; and when

5. A change in paving or compaction equipment occurs.

With the approval of the Engineer, the Contractor may construct additional test strips.

Construct each test strip with approved bituminous mixture. The test strip shall remain in place as a section of the completed work. Construct each test strip to be 1 paver width wide, with an area of at least 400 square yards and of the depth specified for the pavement course concerned.

Immediately after placing the bituminous mixture, begin compacting the test strip. Perform compaction in a continuous and uniform manner over the entire test strip.

Continue compacting the test strip until additional roller coverage will produce no appreciable increase in density (1 pound per cubic foot), as measured using a nuclear gauge. Use the roller coverage necessary to obtain this maximum density as the rolling pattern for the remainder of the project.

Take cores on the test strip at ten locations as designated by the Engineer. Provide these cores to the Department for use in calibrating the nuclear

gauge and to verify that the average density of the test strip meets the density requirements of the specifications. The Department will report all densities using the corrected nuclear gauge readings. Correction factors are specific to the project, mix design and the nuclear gauges used during the test strip construction. If a different mix design or nuclear gauge needs to be used, it will be necessary to cut new cores from the ongoing pavement construction to establish a new nuclear gauge correction factor. Nuclear gauge correction factors determined for a mix design on another project shall not be used.

When testing test strip cores, the Department will determine density (bulk specific gravity) in accordance with AASHTO T 166, Method A only. All core samples shall be completely dry before testing. Air drying is permitted provided core samples are weighed at 2-hour intervals until dry in accordance with AASHTO T166, Section 6.1. Cores may also be dried in accordance with ASTM D7227.

If the density of the asphaltic concrete in the test strip does not meet specification requirements, make whatever changes are necessary to obtain the specified density. Use other sources and combinations of aggregates as necessary, subject to the Engineer's approval, to produce a mix meeting the required density.

407.16 Joints

Place bituminous paving as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture unless approved by the Engineer. Form transverse joints by cutting back on the previous run to expose the full depth of the course. Use a brush or sprayed coat of bituminous material on contact surfaces of longitudinal and transverse joints just before placing additional mixture against the previously rolled material.

407.17 Pavement Samples

When directed, cut samples from the compacted pavement for testing by the Engineer. Take samples of the mixture for the full depth of the course at locations selected by the Engineer. Cut the samples with a power saw or core drill. Samples shall have a top surface area of at least 10 inches.

Fill holes left by taking samples with the same type mixture that was used to construct the course sampled, and compact to conform to the surrounding pavement. Cut samples and repair sample holes at no cost to the Department.

407.18 Surface Requirements

Test the surface with a 12-foot straightedge applied parallel to the centerline of the pavement. The deviation of the surface from the testing edge of the straightedge shall not exceed that specified for the respective types of bituminous construction under the applicable Subsections of these Specifications.

Test the transverse slopes of tilted pavements with a string-line and string-level applied at right angles to the centerline of the pavement. The percent of slope, when computed for the full width of the pavement, shall not deviate more than 0.5 percentage points from that shown on the Plans.

Test the crown in crowned pavements with a string-line applied at right angles to the centerline of the pavement. The crown shall not deviate more than ½ inch from that shown on the Plans.

Correct deviations that exceed the specified tolerances. Remove and replace pavement that cannot be corrected to comply with the specified tolerances at no cost to the Department.

COMPENSATION

407.19 Method of Measurement

The Department will measure:

1. Asphalt cement and mineral aggregate, including mineral filler when required, by the ton and as follows:

    a. If the mix is loaded from a storage or surge bin, the Department will determine quantities by weighing the completed mix on truck scales meeting **109** and calculating the weight of asphalt cement and mineral aggregate based on the percentages measured into the mix by the appropriate scales or meters as specified in **407.04**.

    b. If the mix is loaded directly into the hauling equipment from a batch plant, the Department will measure asphalt cement and mineral aggregate in batch quantities by scales or scales and meters as specified in **407.04.B.**

c. If a continuous mix plant is used, the Department will measure Bituminous Material for Bituminous Plant Mix Pavement by the ton in accordance with **109**. The Department will determine quantities of mineral aggregate, including mineral filler when required, by weighing the bituminous pavement mixture on truck scales meeting **109**, and deducting the weight of the bituminous material from the weight of total mixture accepted.

d. If recycled mix is permitted, the Department will measure the completed mix, including new mineral aggregate, planings, asphalt cement, and additive, by the ton in accordance with **109**.

2. Removal and disposal of existing surface (concrete) by the square yards in accordance with **109,** if such work is required as specified in **407.10**. Such measurement will include the removal of bituminous overlay.

3. Removal and Disposal of Existing Surface (Bituminous) by the square yards in accordance with **109**. Such measurement shall include the removal of base material, except concrete, as directed by the Engineer.

4. Removal of unsatisfactory subgrade material where existing pavement has been removed by the cubic yard, in accordance with **203.09**. The Department will measure material used to replace such undercutting in accordance with the specification for the type of material used.

5. Adjustment of catch basin grates and frames, water valve boxes, gas valve boxes and manhole covers and frames by each when required.

6. Liquid anti-strip additive by the gallon.

7. Hydrated lime by the ton.

The Department will measure bituminous mixtures used to fill openings left by pavement removal as specified in this Subsection **407.19**. The Department will measure base materials used to fill openings left by base removal as provided for in the respective Sections for each type specified.

The Department will not measure chemical additives or modifiers, when required, for payment, but will consider them incidental to asphalt cement.

The Department will not measure mineral filler separately for payment, but will consider it incidental to mineral aggregates.

407.20 Basis of Payment

A. General

The Department will pay for accepted quantities of Asphaltic Concrete (Hot Mix) with or without recycled material, at the contract prices, complete in place, as follows:

Item	*Pay Unit*
Bituminous Plant Mix Base (Hot Mix)	Ton

The Department will pay for liquid anti-strip additive and hydrated lime anti-strip additive based on certified documentation of material costs not to exceed $15 per gallon and $90 per ton, respectively.

The Department will pay for accepted quantities of Prime Coat or Tack Coat as specified in **402** or **403**, respectively.

The Department will pay for the work required to prepare the subgrade, sub-base, base, or surface in accordance with **307.06** and **411.06** as provided for in the applicable Section or Subsection under which the work is performed.

The Department will not make direct payment for polymer or other asphalt modifiers, but will consider such additives to be included in the price bid for the modified asphalt cement or modified mixture.

B. Acceptance of the Mixture

1. **General.** The Department will perform all necessary sampling and testing for acceptance purposes in strict conformance with the Department's Policies in addition to monitoring and observing the Contractor's quality control test procedures and results. However, the Engineer will reject for use in the work any load or loads of mixture which, in the Engineer's opinion, are unacceptable due to excessive segregation, improper coating of aggregates, or excessively high or low temperature.

The Engineer will accept bituminous mixture at the plant with respect to gradation and asphalt content, on a lot basis. A standard size lot at the asphalt plant will consist of a continuous shift's production that does not start over at Midnight. The number of sublots in a lot will vary according to Table 407.20-1.

Table 407.20-1: Sublot Requirements

Quantity (tons)	Number of Sublots
3001 – 4000	4 tests
2001 – 3000	3 tests
1001 – 2000	2 tests
Less than 1000	1 test

When the total plan quantity of any mix is less than 1,000 tons, the Department will accept the mix on the basis of visual inspection and Contractor Quality Control certification. If the daily production of any mix is less than 100 tons, no tests will be required for that quantity of mix. The Department may run extraction, gradation analysis, or other tests deemed necessary for acceptance purposes.

2. **Defective Materials**

a. **Acceptance or Rejection.** Consider the Engineer's decision to be final as to the acceptance, rejection, or acceptance at an adjusted payment of the lots.

It is the intent of these specifications that each lot of material will meet specification requirements at the time of acceptance testing. The Department will not take check samples for acceptance purposes.

All acceptance samples will be split, and half of the sample will be retained by the Inspector. If the results of an acceptance test are questioned, the Central Laboratory will test the remaining half of the acceptance sample. The Department will use the results obtained by the Central Laboratory to evaluate the quality of the lot.

b. **Disposition of Lots.** Remove and replace, at no cost to the Department, nonconforming lots of materials, products, or complete construction that cannot be corrected by reworking.

Alternatively, the Department may accept the nonconforming work at an adjusted payment as specified in these Specifications or as directed by the Engineer.

When a deficiency is determined, the Department will apply the applicable payment as specified in these Specifications to the entire lot. When multiple deficiencies occur, the Department will apply the applicable partial payments to the lot of material that is identified by each deficiency. The Department will apply the payment adjustment for each deficiency separately to not affect any other payment adjustment occurring for the same lot; however, if there are two or more deficiencies in the gradation acceptance tests, the Department will apply only the greater payment adjustment. When an area or linear measurement is used to specify lot size, the Department will determine the equivalent tons of mix placed in each lot by using the average calculated spread from the plant inspector's daily report for that day's production.

3. **Acceptance.** The Engineer will base acceptance of the mixture on test results of consecutive random samples taken from each lot. One random sample will be taken from each sublot. The bituminous mixture will be sampled at the plant according to AASHTO T 168. The percent bitumen content of the mixture will be determined according to AASHTO T 164 or by AASHTO T 308 except as herein revised.

   The Contractor may use an approved ignition furnace instead of a vacuum extractor for the use in determining asphalt content and gradation. The method of calibration and test procedures shall comply with AASHTO T 308 Method A and the following.

   Monthly, per mixture, the Engineer shall determine the correction factor for the ignition oven used for acceptance of the mixture per AASHTO T 308 and adjust the Asphalt Cement content for acceptance of the mixture accordingly. Keep records of all correction factors for all mixtures. Adjusted payment for asphalt content and gradation will be based on the ignition furnace results as specified in Table 407.20-2. Use of this alternative equipment shall be at no additional cost to the Department.

   The percents passing the sieves will be determined in accordance with AASHTO T 30.

Table 407.20-2: Acceptance Schedule of Payment (Asphalt Plant Mix Characteristics)

Characteristics	Pay Factor	Average Arithmetic Deviation of the Lot Acceptance Test from the JMF	
		1 Test	2 Tests or more
All mixes except 411-OGFC Asphalt Cement Content [1] (Extraction or ignition oven)	1.00	0.00-0.30	0.00-0.25
	0.95	0.31-0.35	0.26-0.30
	0.90	0.36-0.40	0.31-0.35
	0.80 [2]	over 0.40	over 0.35
411-OGFC only Asphalt Cement Content (Extraction or ignition oven	1.00	0.00-0.30	0.00-0.25
	0.90	0.31-0.35	0.26-0.30
	0.80	0.36-0.40	0.31-0.35
	0.60[2]	over 0.40	over 0.35
Gradation 3/8 inch sieve and larger	1.00	0.00-6.50	0.00-5.70
	0.95	6.51-7.08	5.71-6.20
	0.90	7.09-7.66	6.21-6.69
	0.80 [2]	over 7.66	over 6.69
Gradation No. 4 sieve [3]	1.00	0.00-4.62	0.00-4.00
	0.95	4.63-5.20	4.01-4.50
	0.90	5.21-5.77	4.51-5.00
	0.80 [2]	over 5.77	over 5.00
Gradation No. 8, 16, 30, & 50 sieves [3]	1.00	0.00-3.80	0.00-3.30
	0.95	3.81-4.46	3.31-3.91
	0.90	4.47-5.12	3.92-4.52
	0.80 [2]	over 5.12	over 4.52
Gradation No. 100 & 200 sieves [3]	1.00	0.00-1.80	0.00-1.60
	0.95	1.81-2.00	1.61-1.75
	0.90	2.01-2.20	1.76-1.90
	0.80 [2]	over 2.20	over 1.90

[1] Does not apply to 307 Grading A, AS, or ACRL mixes.

[2] If approved by the Engineer, the Contractor may accept the indicated partial pay. The Department may require removal and replacement at no cost. The Contractor may remove and replace at no cost to the Department at any time.

[3] When there is more than one reduced payment relating to gradation in 1 lot of material, only the greatest reduction in payment will be applied. Reductions applicable for any other reason will be cumulative.

Deduction for both asphalt content and gradation deficiencies will be cumulative. The Department will apply deductions to the total price of the mix (asphalt cement and aggregate combined) under the item for Asphalt Cement Content and Gradation Deduction.

4. **Additional Tests.** The Engineer may perform any test at any time to determine the effectiveness of the Contractor's quality control. In addition, the Department will conduct production verification tests parallel to that which is defined for quality control in **407.03.D.2.h**.

5. **Acceptance for Mix Density on the Roadway.** The Department will apply a deduction in payment, not as a penalty but as liquidated damages, for failure to meet the density requirements specified in **407.15**. As soon as practicable after the final rolling is completed on each lot, the Department will perform 5 density tests at locations determined by the Engineer, and will compute an average of all such tests. Deductions for failure to meet density requirements will be computed to the nearest 0.1% as a percentage of the total payment otherwise due for each lot. The percent of total payment to be deducted will be 5 times the percent the average in-place density for each lot that fails to meet **407.15**. The Department will make deductions in monies due the Contractor for failure to meet the density requirements under the item for Density Deduction. The Department will conduct acceptance testing for density in accordance with ASTM D2950 unless otherwise specified. For projects with total project tonnage per mix type less than 2,000 tons (not including small quantity jobs as defined in **407.20.B.1**) the Department may alternatively calculate in place density by cores (AASHTO T-166), in this case no cores will be taken for gauge correlation on the test strip. The Department inspector conducting the density tests shall be a certified Nuclear Gauge Field Technician.

   For density testing purposes, the Department will divide the pavement into lots of 1,000 tons. Five density tests will be performed in each lot and the average results compared with the requirements specified in Table 407.15-1. At the beginning of a project or at any time it is deemed advisable, the Department may consider smaller lots to evaluate compaction methods or for other reasons as approved or directed by the Engineer.

   The Department will randomly select acceptance test samples that are representative of the lot or sublot. Although performing compaction after the acceptance test is acceptable, the Department

will use the original test result to determine lot density. The Department may take information only samples to spot check compaction, but will not use these tests for acceptance testing.

C. Adjustments

1. **Asphalt Cement Adjustment.** If the Engineer sets an asphalt content other than that specified in Tables 307.09-1 and 411.09-1, the Department will calculate a price adjustment, based on the asphalt content set by the Engineer and the Monthly Bituminous Index for the specific grade asphalt on the mix design, according to the following formula:

$$PA = \frac{MBI \times (DA - BA) \times T}{100}$$

Where:

PA	=	Price Adjustment
MBI	=	Monthly Bituminous Index
DA	=	Percent asphalt set on the mix design
BA	=	Percent asphalt specified above to be used for bidding
T	=	Total tons asphalt mix for price adjustment

2. **Specific Gravity.** In cases where the effective combined specific gravity of the mineral aggregate exceeds 2.80, the Department will adjust the tonnage of mineral aggregate, or plant produced mixture, for payment by multiplying the tonnage of mineral aggregate, or plant produced mixture, used by a specific gravity of 2.80 and dividing by the higher specific gravity.

3. **Loss on Ignition (LOI).** If the approved JMF includes a surface mixture of limestone with gravel, granite, slag, quartzite or gneiss, perform tests for the percent LOI of the limestone aggregate in the asphalt paving mix as specified in **407.03.E.3**.

   If the percent of LOI in the aggregate differs by plus or minus 2% from the LOI indicated in the JMF, the Department will make a payment deduction in the price bid for the mix, not as a penalty but as liquidated damages. The percent of total payment to be deducted will be 5 times the percent that the LOI exceeds the JMF tolerance of plus or minus 2%.

Replace or overlay all mix produced with aggregate tested and found to have a LOI that differs plus or minus 6% from the LOI indicated in the JMF at no additional cost to the Department.

To determine the deduction, the Department will use lots of approximately 5,000 square yards. The Department inspector will perform sampling and testing to establish the LOI according to the Department's sampling and testing procedures. If the initial tests indicate a variation in the LOI of plus or minus 2% than the value shown on the mix design, the Contractor shall perform the additional sampling necessary to establish the LOI of the aggregate in each lot, with the cost of the sampling being included in the contract unit prices bid for the paving items.

The Department will make deductions for excess variation in LOI under the item for Material Variation (Deduction).

SECTION 410 – BITUMINOUS PLANT MIX SURFACE COURSE (COLD MIX)

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DESCRIPTION

410.01 Description

This work consists of constructing a Bituminous Plant-Mix Surface Course (Cold Mix), composed of aggregate and bituminous material, on a designated base in one or more layers and at the rate of application shown on the Plans or established by the Engineer.

MATERIALS

410.02 Materials

Provide materials as specified in:

Mineral Aggregate **903.10**
Emulsified Asphalt, Grade AE-3 ..... **904.03**

The Engineer will accept mineral aggregate for gradation in the stockpile at the paving plant site, and plant mixed material after being spread on the road. The Engineer may conditionally accept bituminous material at the source.

410.03 Composition of Mixtures

Combine the specified mineral aggregate and bituminous material in such proportions as to produce mixtures within the master composition limits specified in Table 410.03-1.

Table 410.03-1: Proportions of Total Mixture, Percent by Weight

Material Components	Percent by Weight
Mineral Aggregate	93.0 – 95.0%
Emulsified Asphalt	5.0 – 7.0%

EQUIPMENT

410.04 Equipment

Provide equipment as specified in **407.04** with the following modifications:

1. Automatic screed control devices will not be required on the bituminous pavers.

2. Plant equipment required for heating or drying materials and for blending different size aggregates will not be required.

CONSTRUCTION REQUIREMENTS

410.05 Limitations

Comply with the limitations specified in **407.09**.

410.06 Preparing Designated Surface

Prepare the designated surface upon which the material is to be placed as specified in **404.05**.

410.07 Mixing

Perform mixing as specified in **407.13**. The Contractor may either stockpile the mix or haul it directly from the mixer to the road. If stockpiled, ensure that the material shows no damage from weather or signs of stripping during handling.

410.08 Spreading and Finishing

Perform spreading and finishing and spreading choker aggregate as specified in **407.14**.

410.09 Compaction

Perform compaction operations as specified in **407.15**.

410.10 Surface Requirements

Comply with the surface and testing requirements specified in **407.18** to ensure that the deviation of the surface from the testing edge of the straightedge does not exceed ¼ inch.

410.11 Maintenance

Perform maintenance as specified in **404.09**.

COMPENSATION

410.12 Method of Measurement

The Department will measure Mineral Aggregate and Emulsified Asphalt for Bituminous Plant Mix Surface Course (Cold Mix) in accordance with **407.19**.

410.13 Basis of Payment

The Department will pay for accepted quantities of Bituminous Plant Mix Surface Course (Cold Mix) at the contract prices, complete in place, as follows:

Item	*Pay Unit*
Emulsified Asphalt	Ton
Mineral Aggregate (Including Choker)	Ton

The Department will measure and pay for the work required to prepare the designated surface, as provided for under **410.06**, in accordance with the applicable Section or Subsection under which the work is performed.

SECTION 411 – ASPHALTIC CONCRETE SURFACE (HOT MIX)

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DESCRIPTION

411.01 Description

This work consists of constructing an asphaltic concrete pavement, composed of a mixture of coarse aggregate, fine aggregate, mineral filler if specified or required, and asphalt cement, on a prepared roadbed at the rate of application shown on the Plans or established by the Engineer.

The provisions of **407** shall apply to this work unless otherwise stipulated.

MATERIALS

411.02 Materials

Provide materials as specified in:

Mineral Aggregate **903.11**
Mineral Filler **903.16**
Asphalt Cement, PG 64-22, 70-22, 76-22, or 82-22 ..... **904.01**
Chemical Additive **921.06.B**

The Engineer will accept mineral aggregate, bituminous material, and plant mix in accordance with **407.02**.

411.03 Composition of Mixtures

A. General

Composition of mixtures shall be as specified in **407.03**.

B. Proportioning

Combine the specified mineral aggregate and asphalt cement according to the proportions specified in Table 411.03-1.

Table 411.03-1: Proportions of Total Mixture, Percent by Weight

Surface Course	Effective Combined Mineral Aggregate	Asphalt Cement
Grading D	93.0 – 94.3	5.7 – 7.0 (1)
Grading E (2)	93.0 – 94.3	5.7 – 7.0 (1)
Grading E (shoulders)	92.0 – 94.7	6.0 – 6.5 (1)
Grading TL	92.5 – 94.3	5.7 – 7.5 (1)
Grading TLD	93.0 – 94.3	5.7 – 7.0 (1)
Grading TLE	93.0 – 94.3	5.7 – 7.0 (1)
Grading OGFC	92.0 – 94.0	6.0 – 8.0 (1)

(1) If the effective combined specific gravity of the aggregate exceeds 2.80, the above proportions may be adjusted as directed by the Engineer. The upper limit for flow values shall not apply to mixes with modified asphalt liquids.

(2) The minimum allowable asphalt cement content for 411E low volume mixtures is 5.3%.

1. **Grading D.** In addition to the other requirements of these Specifications, the composition of the mineral aggregate shall be such that when combined with the required amount of bitumen, the resultant mixture will meet Table 411.03-2.

Table 411.03-2: Mixture Properties (All Roads)

Mix[1]	Stability, Min. lb-ft [2]	Flow 0.01 inch [3]	Design Void Content % [2]	Production Void Content % [2]	VMA, Min. % [2]	Dust-Asphalt Ratio [4]
411D	2,000	8 – 16	4.0 ± 0.2	3 – 5.5	14	0.6 – 1.2

[1] In order to identify critical mixes and make appropriate adjustments, the mix design shall have these required production properties for the bitumen content range of Optimum Asphalt Cement ±0.25%.

[2] Tested in accordance with AASHTO T 245 with 75 blows of the hammer on each side of the test specimen, using a Marshall Mechanical Compactor.

[3] Flow will only be required when using a non-modified binder (PG 64-22 or 67-22).

[4] The dust to asphalt ratio is the percent of the total aggregate sample that passes the No. 200 sieve, as determined by AASHTO T 11, divided by the percent asphalt in the total mix.

2. **Grading E and TLE.** In addition to the other requirements of these Specifications, the composition of the mineral aggregate shall be such that, when combined with the required amount of bitumen, the resultant mixture will meet Table 411.03-3.

Table 411.03-3: Mixture Properties (High vs. Low Volume Roads)

Mix	Traffic Volume	Stability Minimum lb-ft [1, 3]	Flow 0.01 inch [2]	Design Void Content % [1]	Production Void Content % [1]	VMA, Min % [1]
411E 411TLE	High Volume (ADT > 1,000)	2,000	8 – 16	4.0 ± 0.2	3 – 5.5	14
411E 411TLE	Low Volume (ADT ≤ 1,000)	1,500	8 – 16	3.5 ± 0.5	2 – 5	n/a

[1] Tested according to AASHTO T 245 with 75 blows of the hammer on each side of the test specimen, using a Marshall Mechanical Compactor.

[2] Flow will only be required when using a non-modified binder (PG 64-22 or 67-22).

[3] Minimum stability for shoulder mixes will be 1,500 lb-ft and optimum asphalt cement content for shoulder mixes shall be as directed by the Regional Materials Supervisor.

If the design criteria specified above cannot be obtained with the aggregate submitted to the laboratory for design, provide another source of aggregate.

3. **Gradings TL and TLD.** In addition to the other requirements of these specifications, the composition of the mineral aggregate shall be such that, when combined with the required amount of bitumen, the resultant mixture will meet Table 411.03-4.

Table 411.03-4: Mixture Properties (Gradings TL and TLD)

Mix	Stability, Min lb-ft [1]	Design Void Content % [1]	Production Void Content % [1]	Minimum VMA % [1]	Dust-Asphalt Ratio [2]
411TL	2,000	4.0 ± 0.2	3 – 5.5	16	1.0 – 2.0
411TLD	2,000	3.8 ± 0.3	3 – 5.5	14	0.6 – 1.2

[1] Tested according to AASHTO T 245 with 75 blows of the hammer on each side of the test specimen, using a Marshall Mechanical Compactor.

[2] The dust to asphalt ratio is the percent of the total aggregate sample that passes the No. 200 sieve, as determined by AASHTO T 11, divided by the percent asphalt in the total mix.

4. **Grading OGFC.** In addition to the other requirements of these specifications, the composition of the mineral aggregate shall be such that, when combined with the required amount of bitumen, the resultant mixture will meet Table 411.03-5.

Table 411.03-5: Mixture Properties (Grading OGFC)

Mix	Minimum Void Content %	Voids in Coarse Aggregate % [1]	Max. Cantabro Abrasion Loss (Non-Aged) % [1]	Drain Down Loss % [2]
411OGFC	20	$VCA_{DRC} > VCA_{MIX}$	20	<0.3%

[1] As described in National Asphalt Pavement Association (NAPA) Publication IS-115, "Design, Construction and Maintenance of Open-Graded Friction Courses."

[2] Tested in accordance with AASHTO T 305.

C. Recycled Asphalt Pavement and Recycled Asphalt Shingles

1. **Recycled Asphalt Pavement.** The Contractor may use asphalt pavement that has been removed from a Department project or other State Highway Agency project by an approved method and stored in a Department approved stockpile. RAP combined with the appropriate aggregate, asphalt cement, and anti-strip additive when

required shall produce a mixture that will otherwise meet all the requirements specified in **903.11** and this Section **411**. The Contractor may use RAP in each mix specified in Table 411.03-6.

Table 411.03-6: Use of Recycled Asphalt Pavement

Mix Type	% RAP (Non-processed) [1]	Maximum % RAP (Processed) [2]	Maximum % RAP Processed and Fractionated [3]	Maximum Particle Size (inch)
411D (PG64-22, PG67-22)	0	15	20	½
411D (PG70-22, PG76-22, PG82-22)	0	10	15	½
411E & 411TLE (Roadway)	0	15	20	½
411E & 411TLE (Shoulder)	15	30	35	½
411TL (PG64-22, PG67-22)	0	15	15	5/16
411TL (PG70-22, PG76-22, PG82-22)	0	10	10	5/16
411TLD (PG64-22, PG67-22)	0	15	15	5/16
411TLD (PG70-22, PG76-22, PG82-22)	0	10	10	5/16

[1] "Non-processed" refers to RAP that has not been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that listed above prior to entering the dryer drum.

[2] "Processed" refers to RAP that has been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that above prior to entering the dryer drum.

[3] "Fractionated" refers to RAP that has been processed over more than one screen, producing sources of various maximum particle sizes (e.g., ¾ to ½ inch, ½ inch to #4, etc.). The Contractor may use the larger percentages of fractionated RAP specified only if individual fractions of two different maximum particle size are introduced into the plant as separate material sources for increased control.

All mixes shall contain at least 80% virgin asphalt, except for 411E Shoulder Mix which shall have at least 65% virgin asphalt.

Obtain a representative sample from the recycled material stockpile and establish a gradation and asphalt cement content as required. Determine the gradation and asphalt content of the recycled material at the beginning of a project and every 2,000 tons thereafter. The stockpile asphalt cement content for all recycled material shall not vary from the JMF by plus or minus 0.8%. Table 411.03-7 specifies the stockpile gradation tolerance for all recycled material on each sieve.

Table 411.03-7: Stockpile Gradation Tolerances for Recycled Material

Size	Tolerance
3/8 inch sieve and larger	± 10%
No. 4 sieve	± 8%
No. 8 sieve	± 6%
No. 30 sieve	± 5%
No. 200 sieve	± 4%

The Contractor is responsible for its own sampling and testing of the RAP as well as new materials for bid purposes, and for submitting the JMF as specified in **407.03**. After mixing, the moisture content of the total mix shall be no more than 0.1% as determined by oven drying, and the provisions for lowering the temperature because of boiling or foaming shall not apply.

The Engineer will accept mixture for aggregate gradation and asphalt content based on extractions in accordance with AASHTO T 164 or in accordance with AASHTO T 308.

2. **Recycled Asphalt Shingles (RAS).** Recycled Asphalt Shingles (RAS) may be included to a maximum of 3% of the total weight of mixture. The percentage of RAS used will be considered part of the maximum allowable RAP percentage. The ratio of added new asphalt binder to total asphalt binder shall be 80% or greater for all 411 mixes. Either the mix producer or the RAS supplier shall obtain a representative sample from the recycled material stockpile and establish a gradation and asphalt cement content as required.

Determine shingle asphalt binder content according to AASHTO T 164 Method A, with a minimum sample size of 500 grams. Determine the gradation and asphalt content of the recycled material at the beginning of the Project and every 2,000 tons of recycled material used thereafter. The stockpile asphalt cement content for all recycled material shall not vary by more than 0.8%. All RAS material shall be processed to a minimum 100% passing the 3/8 inch sieve and a minimum 90% passing the No. 4 sieve.

To conduct the gradation testing, air dry a 500 to 700-gram sample of processed shingle material, dry sieve over the 3/8-inch and No. 4 sieves, and weigh. For mix design purposes, the Contractor may use the aggregate gradation specified in Table 411.03-8 as a standard gradation instead of determining the shingle gradation according to AASHTO T 30.

Table 411.03-8: Standard Gradation (for Mix Design Purposes)

Sieve Size	Total Percent Passing
3/8 inch	100
No. 4	97
No. 8	95
No. 16	80
No. 30	60
No. 50	50
No. 100	40
No. 200	30

An aggregate bulk specific gravity (G_{sb}) of 2.650 may be used instead of determining the shingle aggregate G_{sb} according to AASHTO T 84. In addition, the effective binder available for mixing with additional aggregates shall be considered as 75% of the total binder content as determined by AASHTO T 164 and shall be the value listed as the RAS binder content on the JMF.

Scrap asphalt shingle shall not contain extraneous waste materials. Extraneous materials including, but not limited to, asbestos, metals, glass, rubber, nails, soil, brick, tars, paper, wood, and plastics, shall not exceed 0.5% by weight as determined on material retained on

the No. 4 sieve. To conduct deleterious material testing, take a representative 500 to 700-gram sample of processed shingle material, place over the No. 4 sieve, and pick and weigh all extraneous waste material retained on the No. 4 sieve. Base the percent of extraneous material on the total sample weight.

RAS shall contain less than the maximum percentage of asbestos fibers based on testing procedures established by the Department, or State or Federal environmental regulatory agencies. Analyze a minimum of one sample of processed asphalt roofing material for every 500 tons of material processed for the presence of asbestos.

Before a JMF for a particular design is approved, submit the following, along with the materials and information specified in **407.03**:

a. Certification by the processor of the shingle scrap describing the shingle scrap content and source.

b. A 1000-gram sample of the processed RAS material for inspection (new designs only).

Stockpile RAS separately from other salvage material. Do not blend RAS material in a stockpile with other salvage material. Do not blend Manufacture Waste Scrap Shingles (MWSS) and Tear-Off Scrap Shingles (TOSS). In addition, do not blend virgin sand material with the processed shingles, to minimize agglomeration of the shingle material.

All RAS supplied to a Department project shall come from a certified shingle processor/supplier approved by the Division of Materials and Tests.

D. Anti-Strip Additive

Check asphaltic concrete surface mixtures for stripping by the Ten Minute Boil test for dosage rate and ASTM D4867 (Root-Tunnecliff procedure) for moisture susceptibility.

Mix an approved anti-strip agent with the asphalt cement at the dosage specified in **921.06.B**.

EQUIPMENT

411.04 Equipment

Provide equipment as specified in **407.04** through **407.08**.

To construct shoulder mixes with recycled material, provide equipment that complies with **407**, except modify the asphalt plant as approved by the Engineer to accommodate the addition of asphalt planings. If using a batch plant to produce recycled mix, heat the aggregate to a temperature that will transfer sufficient heat to the cold planings to produce a mix of uniform temperature within the specified range.

CONSTRUCTION REQUIREMENTS

411.05 General Requirements

Construct the pavement as specified in **407.09**, **407.11**, **407.12**, and **407.14** through **407.17** and the following Subsections.

411.06 Preparing the Designated Surface

Prepare the designated surface upon which the material is to be placed as specified in **404.05.**

Ensure that loops used for traffic signals are installed before applying the final surface.

411.07 Mixing

Perform mixing as specified in **407.13**. In addition, the mixing cycle for surface course mixtures may require a dry-mixing period.

411.08 Surface Requirements

The surface shall meet the requirements specified in **407.18**, and when tested according to the provisions of that Subsection, the deviation of the surface from the testing edge of the straightedge shall not exceed ¼ inch.

COMPENSATION

411.09 Method of Measurement

The Department will measure Mineral Aggregate, including Mineral Filler when required, Asphalt Cement for Asphaltic Concrete Surface (Hot Mix), and other related items in accordance with **407.19**.

For bidding purposes, use the asphalt cement content specified in Table 411.09-1.

Table 411.09-1: Asphalt Cement Content

Mix Type	Asphalt Content, %
411-D	5.9
411-E Roadway	6.3
411-E Shoulder	6.3
411-TL	6.3
411-TLD	5.9
411-TLE Roadway	5.9
411-TLE Shoulder	5.9
411-OGFC	6.0

If the Engineer sets an asphalt content other than that specified above, the Department will make a price adjustment based on the asphalt content set by the Engineer and the Monthly Bituminous Index for the specific grade asphalt cement on the mix design. The Department will calculate a price adjustment in accordance with **407.20**.

411.10 Basis of Payment

The Department will pay for accepted quantities of Asphaltic Concrete Surface (Hot Mix) or asphaltic Concrete Surface (Hot Mix) (Shoulders) with or without recycled material, at the contract prices, complete in place, in accordance with **407.20**.

SECTION 414 – EMULSIFIED ASPHALT SLURRY SEAL AND MICRO-SURFACING

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DESCRIPTION

414.01 Description

This work consists of the design, testing, construction, and quality control required to apply an emulsified asphalt slurry seal surface (slurry seal) or micro-surface.

The slurry seal or micro-surface shall consist of a mixture of an approved emulsified asphalt, mineral aggregate, water, and specified additives or modifiers, properly proportioned, mixed, and uniformly spread over a prepared surface. The cured slurry or micro-surface shall have a homogeneous appearance, and adhere firmly to the surface.

MATERIALS

414.02 Materials

Provide materials as specified in:

Mineral Filler (Portland Cement) **901.01**

Mineral Aggregate (Slurry Seal)..... **903.12.A**
Mineral Aggregate (Micro-Surface) **903.12.B**
Emulsified Asphalt **904.03**
Water..... **921.01**

For a slurry seal, use a Type CQS-1h emulsified asphalt. For micro-surfacing, use a Type CQS-1hp emulsified asphalt.

Ensure that no deleterious material is introduced into aggregate stockpiled at project site.

414.03 Composition of Mixture

At least 2 weeks before beginning work, submit a signed original of a mix design, performed by a qualified laboratory and covering the specific materials to be used on the Project, to the Materials and Tests Division for acceptance, together with representative samples of each ingredient to be used in the mixture. Identify the samples with information related to sources, type of materials, and project number.

Once the materials are approved, make no substitutions without first testing and obtaining the approval of the laboratory that prepared the mix design. Do not begin work until the Materials and Tests Division has evaluated and accepted the mix design.

Provide a laboratory report showing the results of tests performed on individual materials and comparing their values to those required by this specification. Use job aggregates in all laboratory design tests. Mixing tests shall pass at the maximum expected air temperature in ISSA T113.

A. Slurry Seal

1. **Testing.** The laboratory report shall provide the information specified in Table 414.03-1 for the slurry seal mixture.

Table 414.03-1: Quick-Set Emulsified Asphalt Slurry Seal

Test	Requirement
Mixing Time Test, seconds at 77 °F (TB-113)	120 min
Mix Time, at 50 and 100 °F	(informational)
Set Time Tests:	
30-Minutes-Blotter Test (TB-102)	no brown stain
Displacement Test	no displacement
Water Resistance Test, at 30 minutes (TB-102)	no discoloration
Wet Stripping Test, % coating (TB-114)	90% min
System Compatibility (TB-115)	Pass
Set Time Tests: 30 minutes (TB-139)	12 kg-cm min
Early Rolling Traffic Time: 2 hours (TB-139)	20 kg-cm min
Wet Track Abrasion Test, loss in g/ft^2 (TB-100)	75 max, 6-day soak

For roadways having greater than 1,500 ADT, in addition to the tests specified in Table 414.03-1, the mixture shall also meet the requirements specified in Table 414.03-2 for the ISSA T109, Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion.

Table 414.03-2: Excess Asphalt (for Roadways with > 1,500 ADT)

Roadway ADT	Requirement
1,500 – 3,000	Maximum: 55 grams/psf sand adhesion, 1,000 cycles @ 125 lbs
3,000+	Maximum: 50 grams/psf sand adhesion, 1,000 cycles @ 125 lbs

2. **Composition.** Emulsified asphalt slurry seal shall consist of a uniform mixture of aggregate, emulsified asphalt, latex solids when shown on the Plans, mineral filler, and water. The emulsified asphalt manufacturer shall certify the compatibility of all ingredients (including the mix set additive) of the mix.

The percent of residual asphalt based on the weight of the dry aggregate shall be between 7.5 and 13.5%, with a mixture control tolerance of plus or minus 0.50%.

Ensure that the aggregate gradation and percent residual asphalt, as provided in the slurry seal design accepted by the Engineer, is maintained within the mixture control tolerances stated herein.

The Contractor may add Portland cement to obtain the desired dispersion and working characteristics of the slurry provided that the addition of Portland cement is stated on the slurry seal design, does not exceed 3% of the weight of the aggregate, and has a mixture control tolerance of plus or minus 0.25%.

Portland cement added for dispersion of the slurry seal shall be a commercial quality, non-air entraining cement and shall not be considered as mineral filler for the purpose of satisfying the gradation requirements of the aggregate.

Pre-wet the aggregate with a minimum amount of water before blending with the emulsified asphalt to obtain a fluid, homogeneous slurry mixture of the proper consistency. Do not add to the mix any additional water above that quantity required by the slurry seal mix design to obtain a more workable mixture.

B. Micro-Surfacing

1. **Testing.** The laboratory report shall provide the information specified in Table 414.03-3 for the micro-surface mixture.

Table 414.03-3: Micro-Surfacing

Test	Requirement
Mixing Time Test, seconds at 77 °F (T-102)	120 min
Mix Time, at 50 and 100 °F	(informational)
Set Time Tests: 30 minutes (T-139)	12 kg-cm min
Early Rolling Traffic Time: 60 minutes (T-139)	20 kg-cm min
Wet Stripping Test, % coating (T-114)	90% min
Wet Track Abrasion Test, loss in g/ft^2 (T-100)	75 max 6 days 50 max 1 hour
Measurement of Excess Asphalt (T-109)	50 grams/ft^2 max
	Sand Adhesion, 1,000 Cycles at 125 lbs
Classification Compatibility (T-144)	11 pt. min
Loss on Ignition (LOI) Test, **407.03.E.3**	(informational)

2. **Composition.** For the paving mixture, the design shall verify the functioning of the set regulating additives and shall present certified test results for the Engineer's approval. Aggregate in the mixture shall be representative of material to be used on the Project.

   Obtain the Engineer's approval of the design before using. Proportions for the design shall be within the limits specified in Table 414.03-4.

Table 414.03-4: Micro-Surface Mixture Design Requirements

Material	Requirement
Modified Emulsified Asphalt Residue by Dry Weight of Aggregates	5.0-9.0%
Mineral Additive by Dry Weight of Aggregate	0.5%-3.0%
Latex or Polymer Based Modifier	3% minimum and as required to provide the specified properties
Mix Set Additive	As required to provide the specified properties
Water	As required to produce consistency

The Contractor may add Portland cement to obtain the desired dispersion and working characteristics of the mix, provided that the addition of Portland cement is stated on the micro-surface design, does not exceed 3% of the weight of the aggregate, and has a mixture control tolerance of plus or minus 0.25%.

Portland cement added for dispersion shall be a commercial quality, non-air entraining cement and shall not be considered as mineral filler for the purpose of satisfying the gradation requirements of the aggregate.

Proportion the mixture to achieve the test strip requirements specified in **414.06**.

C. Applicable Specifications

Consider the specifications and test methods identified in Table 414.03-5 to be part of this specification.

Table 414.03-5: Applicable Specifications

Title	Source
Mixing, Setting and Water Resistance Test to Identify "Quick-Set" Emulsified Asphalts	ISSA TB-102
Wet Track Abrasion of Micro Seals	ISSA TB-100
Measurement of Micro-Seal Consistency	ISSA TB-106
Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester	ISSA TB-109
Outline Guide Design Procedure for Slurry Seal	ISSA TB-111
Method to Estimate Micro-Seal Spread Rates and to Measure Pavement Macrotexture	ISSA TB-112
Trial Mix Procedure for Slurry -Seal Design	ISSA TB-113
Wet Stripping Test for Cured Slurry-Seal Mixes	ISSA TB-114
Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester. Measurement of Set and Cure Characteristics	ISSA TB-139
Classification Compatibility	ISSA TB-144
Design, Testing and Construction of Micro-Seal	ASTM D3910
Quantitative Extraction of Bitumen for Bituminous Paving Mixtures	ASTM D2172

The blended asphalt mixture, when combined with aggregate and mineral filler, shall have the following characteristics:

1. Be capable of filling up to ½-inch wheel ruts in one pass.
2. Be capable of field regulation of the setting time.
3. Be suitable for nighttime placement.

EQUIPMENT

414.04 Equipment

Maintain all equipment, tools, and machines used to perform this work in satisfactory working condition. Have available at all times a device capable of determining aggregate moisture within 3 minutes.

Immediately after loading, cover all trucks with a cover of canvas or other suitable material. Allow the cover to lap down along the sides and rear of the truck bed a minimum of 6 inches, and secure with tie downs at a maximum of 5-foot spacing along the sides and rear of the truck bed. Before starting hauling operations, ensure that all trucks are equipped to meet these requirements.

Provide power brooms, power blowers, air compressors, water flushing equipment, and hand brooms capable of thoroughly cleaning all cracks and the old surface. Provide hand squeegees, hand brooms, shovels, and other incidental equipment as necessary to perform work.

A. Mixing Equipment

The mixing equipment shall be re-supplied with all materials while depositing the mixture on the roadway to provide a continuous, non-stop surfacing operation. Produce the paving mixture in a self-propelled, front feed, continuous loading, mixing machine equipped with a positive, non-slipping aggregate delivery system and an interconnected, positive displacement water-jacketed gear pump to accurately proportion ingredients.

Equip the mixing machine with an approved fines feeder that has an accurate metering device or method to introduce a predetermined amount of mineral filler into the mixer at the same time and location as the mineral aggregate. Provide a spray bar to completely wet the aggregate dropping down to the pug mill with additive and water. The twin-shafted multi-blade pug mill shall be a continuous flow type and a minimum of 50 inches long. Introduce the emulsion above the third point of the mixer to ensure proper premixing of the aggregate, cement, additive, and water when the modified emulsified asphalt is added. Blade size and side clearances shall meet the equipment manufacturer’s recommendations.

Perform mixing in a manner that does not cause premature breaking of the emulsified asphalt. The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients.

Equip the mixer with a remote forward speed control at the back mixing platform so the back operator can control forward speed and level of mixture in paving or rut box.

Provide a computerized material monitoring system with integrated material control devices that are readily accessible and positioned so the amount of each material used can be determined at any time. Provide a back-up electronic materials counter that is capable of recording running count totals for each material being monitored. Equip the mixer with a radar ground measuring device. Calibrate each material control device before each mix application and as often thereafter as the Engineer deems necessary. The computer system shall have the capability to record, display and print the following information:

1. Individual sensor counts for emulsion, aggregate, cement, water, and additive
2. Aggregate, emulsion, and cement output in pounds per minute
3. Ground travel distance
4. Spread rate in pounds per square yard
5. Percentages of emulsion, cement, water, and additive
6. Cumulative totals of aggregate, emulsion, cement, water, and additive
7. Scale factor for all materials

Ensure the computer system is functional at the beginning of work and during each calibration.

Equip the mixing machine with a water pressure system and fog type spray bar, adequate for complete fogging of the surface ahead of the spreading equipment.

The mixing machine shall include controls for proportioning and calibrating the aggregate feed. The aggregate feed device shall have a revolution counter, so that the amount of aggregate used may be determined at any time, and a positive locking feed gate.

Provide an emulsion pump of the positive displacement type and equipped with a device that can be used to determine the amount of emulsion used at any time. Arrange the emulsion pump, meter, and

piping to allow calibration of the meter by weighing a metered volume. The pump shall deliver the emulsion to the mixer box at a uniform rate, which shall not vary more than 2% from the required quantity.

Equip the water pump with a minimum of two valves. One valve shall establish the required water flow. The other valve shall be a quick acting valve to start and stop the water flow.

The mixing machine shall have sight gauges located at the material storage tanks for the asphalt emulsion and water.

Equip the mixing machine with approved metering devices that can be used for calibration purposes and for estimating the quantities of materials used during any one period. If the metering devices stop working properly, do not use the mixing machine until the necessary repairs have been made.

Provide satisfactory means to allow positive interlocking control between the flow of aggregate from the bins and the flow of emulsion from the pump. Calibrate each mixing unit in the Engineer's presence before starting construction. Document the individual calibration of each material at various settings, which can be related to the machine's metering devices. When calibrating the emulsion system, run a minimum of three tests, with each test run being a minimum of 40 gallons. To calibrate the aggregate delivery system, perform tests at three different gate settings, with two test runs at each gate setting and a minimum of 425 pounds per test run. To calibrate the filler (cement) delivery system, perform three tests at a minimum of 25 pounds per test. Use certified scales. Only use machines that have been calibrated and accepted by the Engineer to perform the work. The Engineer may require additional calibrations during the process of the work.

B. Spreading Equipment

Attach to the mixer a hydraulically adjustable (adjustable while applying mixture) type spreader box with a positive screed adjustment for yield control and a positive adjustment for the joint matcher. The box shall be equipped with the following: ribbon flights mounted on an adjustable shaft to continually agitate and distribute the materials throughout the box; curb bumpers and replaceable runners with a minimum of 5-foot long end runners; and a sufficient walkway to provide access to either side of the spreader box without walking through the freshly laid material.

The spreader box shall be heavy duty with cross bracing for rigidity and a manufacturer's weight of not less than 1,400 pounds at a width of 12 feet. The box shall be capable of laying mix to a width of 14 feet. The equipment shall provide sufficient turbulence to prevent the mix from setting in the box or causing excessive side build-up or lumps. To prevent loss of mixture from the box, attach flexible seals, front and rear, in contact with the road.

Equip the full width application box with a secondary strike-off located approximately 2 to 3 feet behind the primary strike-off to minimize transverse corrugations. The secondary strike-off shall have elevation and width adjustments similar to the primary strike-off. It shall have a pivot point where it can be tilted for texturing or raised completely off the surface. Rut filling shall require a steel or high density strike-off on the spreading equipment, as approved by the Engineer, or the use of a rut box. Use a rut box for filling ruts in excess of 3/8 inches unless otherwise shown on the Plans.

Operate the spreading equipment to prevent the loss of mixture on super-elevated curves. Spread mixture to fill cracks and minor surface irregularities and achieve a uniform skid-resistant surface without causing skips, lumps, or tears in the finished mat.

For slurry seals, the use of burlap drags or other drags necessary to obtain the desired finish requires the Engineer's approval. Replace drags having excessive build-up. Keep drags in a completely flexible condition at all times. Do not use drags on micro-surfacing.

CONSTRUCTION REQUIREMENTS

414.05 Preparing the Existing Surface

Immediately before applying the tack coat and mixture, remove all dust, dirt, vegetation, and other deleterious material from the existing surface by brooming, washing with water under high pressure, blowing with compressed air, or other approved methods. Obtain the Engineer's approval of the cleaned surface before applying the tack coat and mixture. Remove all thermoplastic pavement markings flush with the existing surface before applying the tack coat.

Establish stations at 1,000-foot intervals on the entire project before placing materials. Clearly identify and maintain the stations until project completion.

414.06 Applying Slurry Seal and Micro-Surfacing

A. Application

Before placing the mixture, apply a tack coat of SS-1h, CQS-1h, or CQS-1hp emulsion with an asphalt distributor. The tack coat shall consist of one part emulsion and three parts water. The application rate shall be 0.10 to 0.15 gallons per square yard of the diluted emulsion. The Engineer will determine the actual application rate. Apply the tack coat as specified in **403.**

Apply the emulsified asphalt slurry seal at a rate of 16 plus or minus 2 pounds per square yard based on dry aggregate weight unless otherwise shown on the Plans. Vary the rate of application within the range specified above as required by the condition of the pavement to obtain a minimum thickness of 1/8 inch above the high points of the milled areas and ¼-inch thickness on unmilled areas.

Apply micro-surface as follows:

1. **Rut-fill Course.** If a rut-fill course is specified, apply enough material to fill the wheel paths without excess crowning (overfilling). An excess crown is defined as 1/8 inches after 24 hours of traffic compaction. Apply rut-fill courses in widths from 5 to 6 feet for each wheel path. Provide a smooth, neat seam where two rut-fill passes meet. Take care to restore the designed profile of the pavement cross-section. Feather the edges of the rut-fill course to minimize the use of excess material.

2. **Leveling Course.** If a leveling course is specified, apply at a rate of 14 plus or minus 2 pounds per square yard based on dry aggregate.

3. **Surface Course.** If a surface course is specified and it is placed over a leveling course, apply at a rate of 18 plus or minus 1 pounds per square yard based on dry aggregate. If a surface course is specified and it is not placed upon another micro-surfacing course, apply the paving mixture at a minimum rate of 22 pounds per square yard based on dry aggregate.

Apply micro-surface at the rates as shown on the Plans for leveling and surface courses.

Apply the mixture based on dry aggregate weight as shown on the Plans.

The maximum allowable speed of the machine shall be 130 feet per minute. The Engineer will determine the maximum allowable speed for rut filling. Place the final surface seal uniformly across the width of the traffic lane unless otherwise specified or directed. The action of the squeegee shall allow the mix to flow freely, leaving a smooth, uniformly textured surface.

Unless otherwise directed by the Engineer, pre-wet the surface with water by fogging ahead of the spreader box. Closely control pre-wetting to prevent water from accumulating to the point of running off or puddling.

As the aggregate and emulsion are being loaded into the aggregate/emulsion support trucks or mixing machine, perform a final screening of the aggregate by sieving it through screening equipment capable of removing random oversize material.

Ensure that the mixture is of the desired consistency when deposited on the surface. Add no additional elements to the mixture once placed. Ensure that a sufficient amount of mixture is carried in all parts of the spreader at all times to obtain complete coverage. Do not allow lumping, balling, or unmixed aggregate, or segregation of the emulsion and aggregate fines from the coarse aggregate. If the coarse aggregate settles to the bottom of the mix, remove the mix from the pavement. The mixture shall have proper consistency to avoid excessive splattering and excessive free water. Do not spray water into the spreader box during lay down operations. Use hand tools, lutes, and squeegees to spread mix on areas not accessible to the machine spreading equipment. After curing, perform rolling with a pneumatic-tired roller for sections of pavement not to be exposed to traffic. The roller shall be equipped with tires with a pressure of 40 to 60 pounds per square inch.

Demonstrate throughout the course of the Project that the number of trucking units being used is sufficient to ensure a continuous forward operation. Repeated stopping and starting of the machine will not be allowed.

B. Quality Control

Produce a mixture that complies with the mix design and the quality control tolerances. Apply the slurry seal or micro-surface at the rates

shown on the Plans. Use the methods described in this section to measure compliance. Maintain all quality control documentation and make it available to the Engineer upon request or at the completion of the work.

1. **Asphalt Content.** Calculate the percent asphalt content of the mixture by randomly reading the equipment computer display a minimum of three times a day. The quality control tolerances from the mix design is plus or minus 0.5%.

2. **Application Rate.** Calculate the yield of the course being placed by randomly reading the equipment computer display a minimum of three times a day. The quality control tolerance from the specified application rate is plus or minus 2 pounds per square yard.

3. **Documentation.** Maintain a lot sheet as follows:

   Divide the Project into lots of each day's production. For each lot, maintain a lot sheet, providing the following information:

   (1) Contract Number, Route

   (2) Date, Air Temperature, Pavement Surface Temperature

   (3) Control Settings, Calibration Values, Unit Weight of Emulsion (pounds per gallon), Percent Residue in Emulsion

   (4) Beginning and Ending Log Miles

   (5) Computer display readings for material usage (Beginning, Ending, and Total)

   (6) Length, Width, Total Area (square yards) of the construction completed for the day

   (7) Aggregate used (dry ton), Asphalt Emulsion used (ton), additives (gallon), water (gallon), and/or Portland Cement (ton)

(8) Application Rate of asphalt emulsion, Combined Application Rate (pounds per square yard)

(9) Mix Design (Percent Portland Cement, Percent Emulsion, Percent Asphalt Cement)

(10) Calibration Forms

(11) Contractor's Authorized Signature

4. **Test Strip Construction.** Prior to production application, place a 1,000 plus or minus 50-foot test section. Place the test strip at the same time as paving is to take place, night or day, and under the same ambient conditions. Ensure the test strip is able to carry normal traffic within 60 minutes. If normal traffic cannot be carried, adjust the emulsion or mixture, and construct another test strip.

414.07 Joints

Prevent excessive build-up, uncovered areas, or unsightly appearance on longitudinal or transverse joints. Avoid excessive overlap on longitudinal joints. Provide spreading equipment of suitable width to produce a minimum number of longitudinal joints throughout the Project. When placing micro-surfacing, terminate the final center joint of the micro-surfacing at a point that will fall directly under the final permanent centerline. Before opening to traffic, apply pavement markings meeting **716.06**. Allow a maximum of 3 inches for overlap of the longitudinal lane line joints. Also, the joint shall have no more than ¼-inch difference in elevation when measured with a 10-foot straightedge over the joint. Extend final edge lines a minimum of 4 inches over the old longitudinal edge joint. Ensure straight lines along curbs and shoulders. Do not allow runoff on these areas. Keep lines at intersections straight to provide a neat appearance.

414.08 Fog Seal Application

Meet **403.05**.

414.09 Weather Limitations

Only place micro-surface and slurry seal when the pavement surface temperature and the ambient air temperature are a minimum of 50 °F and

rising. Do not apply micro-surface or slurry seal during foggy or rainy conditions. Limit placement to the period from April 1 to October 31.

414.10 Opening to Traffic

Micro-surface material shall cure sufficiently within 1 hour after application, and slurry seal material shall cure sufficiently within 2 hours after application, so that traffic can be allowed on the pavement without damaging the surface. Do not allow traffic on the mixture until it has cured sufficiently to prevent pickup by vehicle tires. Maintain traffic control as necessary to prevent damage to the mixture. Repair damage to the mixture caused by traffic at no cost to the Department.

COMPENSATION

414.11 Method of Measurement

The Department will measure:

1. Emulsified Asphalt Slurry Seal by the square yards complete in place and accepted.

2. Micro-Surfacing by:

    a. The square yards complete in place and accepted; or by

    b. The quantity in tons (dry) of aggregate, including mineral filler, and the quantity in tons of latex or polymer modified emulsion used in the accepted portion of the micro-surfacing, based on the calibrated metering device affixed to the micro-surface mixing machine.

3. Bituminous Materials for Tack Coat and for Fog Seal by the ton of undiluted emulsion.

The quantity for "Bituminous Material for Tack Coat", Item No. 403.01, should be ¼ of the estimated application rate. The Department will not directly pay for latex or polymer additives when used and will consider their cost to be included in the price bid for the respective items.

For bidding purposes, assume the emulsified asphalt content for the slurry mix design is 15%. When Micro-Surfacing is bid by the square yard, assume

the design asphalt content is 12%. If the Engineer sets an emulsified asphalt content for slurry seal other than that stated above, the Department will make a price adjustment based on the emulsified asphalt content set by the Engineer and the invoice price of the emulsified asphalt F.O.B. the project delivery point. The Department will calculate the price adjustment according to the following formula:

$$PA = \frac{[IP \times (DA - BA) \times T]}{100}$$

Where:

PA =	Price Adjustment
IP =	Invoice price of emulsified asphalt cement
DA =	Percent emulsified asphalt set on the mix design
BA =	Percent emulsified asphalt specified above to be used for bidding
T =	Total tons of aggregate for price adjustment as determined by the metering system on the mixing machine

The Department will make payment to the Contractor for additional emulsified asphalt as provided for above at the purchase price F.O.B. the project delivery point, as verified by invoice, with no compensation allowed for further handling or processing. The Department will be reimbursed from monies due the Contractor for a decrease in emulsified asphalt content in the amount equal to the purchase price F.O.B. the project delivery point.

414.12 Basis of Payment

A. General

The Department will pay for accepted quantities, determined in accordance with **414.11**, at the contract prices, complete in place, which payment shall be full compensation for all equipment, materials, labor and incidentals necessary to complete the work.

B. Adjustments

1. Loss on Ignition (LOI). A price adjustment for LOI shall be applied on a project basis per **407.20.C.3**.

2. Specific Gravity. In cases where the Bulk SSD specific gravity of the mineral aggregate exceeds 2.80, the Department will adjust the

tonnage of mineral aggregate for payment by multiplying the tonnage of mineral aggregate used by a specific gravity of 2.80 and dividing by the higher specific gravity.

SECTION 415 – COLD PLANING OF BITUMINOUS PLANT MIX PAVEMENTS

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DESCRIPTION

415.01 Description

This work consists of cold planing an existing bituminous plant mix pavement.

EQUIPMENT

415.02 Equipment

Provide a power broom, a water truck, and a planing machine, as well as equipment to remove the material planed from the pavement.

The planing machine shall be a power operated, self-propelled milling machine or grinder capable of removing bituminous concrete to the required width, depth, profile, cross-slope, and surface texture. The machine shall be capable of accurately establishing profile by referencing from either the existing pavement or from an independent grade control and shall have positive means for controlling cross-slope. The machine shall have a floating moldboard with sufficient down pressure to plane the milled surface. The machine shall have an effective means of removing cuttings from the pavement and for preventing dust from escaping into the air.

When milling the Interstate or controlled access freeways, the planing machine shall be capable of restoring pavement profile with a non-contact leveling system. The non-contact leveling system shall have a minimum of three sensors dispersed the length of the machine.

The maximum spacing between teeth on the cutter drum shall not exceed 5/8 inches. Provide supplemental equipment as necessary to remove material in areas that cannot be reached by the planing machine.

CONSTRUCTION REQUIREMENTS

415.03 General Requirements

Coordinate operations so that vertical longitudinal faces do not exceed 1-1/4 inches in height in areas to be used by public traffic. Taper transverse faces in a manner approved by the Engineer to avoid creating a traffic hazard. Perform cold planing in the direction of traffic.

When milling roadways for hot mix overlays, operate the planing machine at a consistent forward speed to provide an acceptable surface texture. The maximum allowable forward speed shall be 60 feet per minute when the teeth spacing is between ½ and 5/8 inches, and 80 feet per minute when the teeth spacing is less than ½ inch.

After planing, ensure that the finished surface provides a smooth riding surface free of scallops, scabs, gouges, ridges, oil film, and other imperfections of workmanship, has a uniform texture, and is true to the required grade and cross-section. The elevation of the longitudinal edges of adjacent cuts shall not differ more than 1/8 inch.

Do not begin milling unless the subsequent layer of pavement can be placed within the limitation specified in **407.09**.

Thoroughly sweep the planed pavement immediately behind the machine, and haul away all materials swept up. When the Engineer deems necessary, provide and use a water truck to control dust.

Where sound pavement has been gouged, torn, or otherwise damaged during the milling operations, or damage is done to any other property of any kind including utility frames, grates, and covers, make repairs at no cost to the Department. Take appropriate measures so that the cold planing operation does not trap water.

415.04 Surface Requirements

Where the planed pavement is not to be resurfaced, provide a uniform texture throughout the Project and a satisfactory riding surface. The average texture depth shall be no less than 0.20 inches.

The finished surface on the Interstate and controlled access freeways shall be of uniform profile throughout, without any scabbing, scallops, gouges, ridges, or other imperfections resulting from worn cutter teeth, improper operating speeds, poor equipment maintenance, or other instances of poor workmanship. The cross-slope shall be as shown on the Plans in the tangent, transition, and super-elevated curve sections.

The finished surface after the final cut shall not show a deviation greater than 1/8 inch from a 10-foot straightedge, and the cross-slope shall not deviate more than 3/8 inches in 10 feet. Correct all irregularities exceeding these limits.

Texture all approaches and tapers when required by the Engineer. Length, width, and depth of cut on approaches and tapers shall be as determined by the Engineer. Match the approaches and tapers to the finished cut on the main line, and transition to the existing surface to within plus or minus 1/8 inch.

When deemed necessary by the Engineer, transition private entrances to provide a smooth approach to the roadway.

Unless otherwise shown on the Plans, take ownership of the cuttings and remove them from the Project.

COMPENSATION

415.05 Method of Measurement

The Department will measure Cold Planing of Bituminous Pavement by the quantity of material removed in tons or cubic yards, or by the square yard of planed pavement. The method of measurement will depend upon the pay item designated in the proposal.

Where payment is by the square yard, the Department will measure the pavement acceptably planed by the square yard in accordance with **109.**

Unless otherwise specified, the Department will not measure water used to control dust for separate payment but will consider it incidental to the planing operation.

415.06 Basis of Payment

The Department will pay for the accepted quantity of Cold Planed Bituminous Pavement at the contract unit price, which payment shall be full compensation for all labor, materials, equipment, hauling, and incidentals necessary to plane the pavement, control dust, and dispose of the cuttings.

SECTION 712 – TEMPORARY TRAFFIC CONTROL

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DESCRIPTION

712.01 Description

This work consists of furnishing, erecting, and maintaining all construction warning signs, barricades, flexible drum channelizing units, temporary pavement markings, and other traffic control devices in accordance with the provisions of the current edition of the MUTCD, including all addenda, or as shown on the Plans or as directed by the Engineer for the purpose of safely directing traffic through construction zones. This work shall include installing additional devices as necessary in construction work zones.

MATERIALS

712.02 Materials

Provide traffic control and marking devices in accordance with the current edition of the MUTCD, except as herein modified.

Provide materials as specified in:

Signs:
- Aluminum **916.02**
- Reflective Sheeting **916.06**
- Paint **916.09**

Cold Rolled Carbon Steel -16 gauge ..... ASTM A1008
Non-metallic Drums and Barricades..... QPL
Reflective Sheeting..... **916.06**

A. Sign Sheeting Material

Sign sheeting material for all temporary construction signing shall be Type B or better, Fluorescent Orange color meeting the requirements of AASHTO M 268 and **916.06**. For all interstate projects, provide new fluorescent orange sign sheeting material; for all other construction projects, provide new or previously used sign sheeting that is in good condition.

B. Temporary Pavement Marking Material

Unless otherwise specified, the material for pavement marking line shall be either temporary pavement marking tape, or reflectorized paint with raised reflective pavement markers placed as shown on the Plans.

Where Removable Pavement Markings are specified, provide materials listed on the Department's QPL. Before use, the manufacturer shall certify to the Department that the removable tape is identical to that listed on the Department's QPL. Failure of the removable tape to perform satisfactorily with regard to installation or removability is cause for rejection of the material.

C. Cones

Cones shall be a minimum of 28 inches high and weighted at the base.

D. Portable Barrier Rail

Portable barrier rail shall meet the requirements of and be listed on the Department's QPL or Standard Drawings.

Provide certification from the supplier that the proposed portable barrier meets the requirements of and is listed on the Department's QPL or Standard Drawings. Submit all certification documents to the Engineer before delivery to the Project. Do not use different shapes, lengths, or connections of rail in the same continuous run.

E. Portable Impact Attenuators

Portable impact attenuators shall be in accordance with the Plans and Specifications, meet the requirements for the appropriate test level, and meet the requirements of and be listed on the Department's QPL or Standard Drawings.

F. Sign Supports

Stationary sign supports shall be steel posts meeting **916**. Do not use wood for stationary or portable sign supports. Provide portable sign supports that meet the requirements of and are listed on the Department's QPL or Standard Drawings. In splicing supports, use 5/16-inch diameter galvanized ASTM A449 (SAE J429 Grade 5) or galvanized ASTM F3125 Grade A325 bolts.

G. Vertical Panels

The substrate material for vertical panels shall be aluminum, meeting the requirements of **916.02**, or a high density copolymer polyethylene. The high density copolymer polyethylene shall be flexible and shatterproof for temperatures to -50 °F (ASTM D746). The reflective sheeting shall be AASHTO M 268 Type B or better, meeting the requirements for Fluorescent Orange material as specified in **916.06**. Attach the vertical panel (aluminum or copolymer) to a steel "U" post (weight 2.0 pounds per foot) meeting the requirements of **916.03**.

H. Flexible Drums, Flashing Arrow Boards, and Changeable Message Signs

Select Flexible Drums, Flashing Arrow Boards, and Changeable Message Signs that meet the requirements of and are listed on the Department's QPL or Standard Drawings.

Traffic control devices defined by the FHWA as Work Zone Category 1 and Category 2 devices weighing less than 100 pounds. Select all Category 1 and Category 2 devices that meet the requirements of and are listed on the Department's QPL or Standard Drawings. Alternatively, the Contractor may submit a notarized letter, along with documentation from the FHWA Office of Safety, certifying that Category 1 devices and Category 2 devices weighing less than 100 pounds meet the requirements of the Department's QPL and Standard Drawings.

Submit all certification documents to the Engineer before delivering these traffic control devices to the Project.

712.03 Reserved

CONSTRUCTION REQUIREMENTS

712.04 General

At the pre-construction conference, designate a responsible person who will be assigned to the Project to supervise traffic control.

Erect signs in a workmanlike manner such that all supports are plumb, sign panels are generally perpendicular to the travelway, and legends are horizontal so that they effectively convey the intended message. Do not display advanced warning signs more than 48 hours before physical construction begins. The Contractor may erect signs up to one week before needed, if the sign face is fully covered in a manner approved by the Engineer. Ensure that the sign sheeting is free of any damage that would reduce the reflectivity. Do not use overlay plates on signs. Mount signs on stationary or portable supports dependent on the type work being performed. Drive sign supports a minimum of 3.5 feet into soil or 1 foot into solid rock. Where soil and solid rock are both encountered, the depth of the sign support in the ground shall be:

$$d_1 + 3.5d_2 = 42$$

where

d_1 = depth in inches of support in soil
d_2 = depth in inches of support in solid rock

The Contractor may splice stationary U-Post sign supports that are 3 lbs/ft or less, provided the splice is a minimum of 18 inches. In addition, drive the stubs for the splice as required above and so as not to extend above 18 inches from ground level. A splice is only allowable with U-Posts and shall not be permitted for any other post types (square tube, round post, I-beam, etc.). Fasten the splice with four bolts, two placed at each end of the splice. In general, work being performed at spot locations and of short duration will necessitate the use of portable supports properly weighted for stability.

During periods of non-use, remove warning signs and other devices from the work area, and cover or otherwise position them so they do not convey their

message to the traveling public and do not present a safety hazard to drivers. If covered, maintain the covering material in a neat and workmanlike manner during its use. The method of covering the sign face shall not deface or damage the sheeting of the sign.

Use flashing or steady burning lights to light barricades and other devices that require lighting, as shown on the Plan details or as directed by the Engineer. Procure and bear the expense of a continuous power source.

A. Flaggers

Provide flaggers with proper attire and paddle when necessary to safely handle traffic through the construction zone. Ensure that flaggers are trained and certified in flagging operations by one of the following training programs:

1. American Traffic Safety Services Association (ATSSA)
2. National Safety Council (NSC)
3. Tennessee Transportation Assistance Program (TTAP)
4. ABET Accredited University Programs

The Department will accept flagger training programs developed and conducted by construction industry associations, consultant organizations, and contractors if they have an established, written program that meets all MUTCD requirements and Department Policy.

The Department will review and determine if an alternative training program is acceptable prior to use. Alternative training programs shall meet all MUTCD requirements and follow FHWA guidance.

The Department will consider flaggers to be a general requirement of traffic control and will not make direct payment for such.

Coordinate flagging operations in a manner that causes as little delay to the traveling public as possible. Delays shall be kept within 2 minutes or ¼ mile, but shall not exceed 5 minutes or a 1 mile maximum, unless prior authorization is granted by the Department.

B. THP Troopers and Uniformed Law Enforcement Officers

When requested by the Engineer or the Contractor and approved by the Regional Safety Coordinator or Regional Operations Office, a Tennessee Highway Patrol (THP) Trooper may be provided to enforce motor

vehicle laws and otherwise assist in securing the public safety. Submit requests for the THP at least 48 hours in advance of the requested time of service. If the THP is scheduled to work and the work is canceled, or the schedule is changed, notify the THP and the Engineer at least 2 hours before the scheduled start of work.

When a THP Trooper is not available, the Contractor may provide a Uniformed Law Enforcement Officer if approved by the Engineer and the Regional Safety Coordinator or Regional Operations Office. All Uniformed Law Enforcement Officers shall provide marked law enforcement vehicle equipped with blue lights and have the authority to write traffic tickets and make arrests within the project site. The Uniformed Law Enforcement Officer shall maintain a detailed written log of enforcement activities and shall submit the log to the Engineer for verification each month.

All Uniformed Law Enforcement Officers working on Department projects shall have training from a Peace Officer Standards and Training (POST) certified police training academy in the State of Tennessee and an additional 4 hours of FHWA approved work zone training. Submit records of this training to the Engineer.

C. Flashing Arrow Board

Install Flashing Arrow Board(s), meeting all requirements of the MUTCD, at the locations shown on the Plans or as directed by the Engineer. Ensure that the Flashing Arrow Board(s) will perform as specified herein. Correct or immediately replace all Flashing Arrow Boards that exhibit any type of malfunction, including improper dimming.

The Flashing Arrow Board shall be capable of displaying the following configurations:

1. Right Arrow – ten lamps flashing in unison forming an arrow
2. Left Arrow – ten lamps flashing in unison forming an arrow
3. Double Arrow – five lamps in each arrow head and three lamps in a common shaft all flashing in unison
4. Four Point Caution – four outermost corner lamps flashing in unison

Use the Flashing Arrow Board(s) in the single arrow mode for lane closure only, and situate and align them so that the flashing arrow is

clearly visible and legible. The single arrow mode display shall have ten lamps flashing in unison. Do not use the sequential arrow configuration, chevron arrow configuration, and horizontal bar configuration. The flash rate shall not be less than 25 flashes per minute or more than 40 flashes per minute. Minimum lamp "on-time" shall be 50% of the cycle.

Mount the Flashing Arrow Board(s) so as to provide a minimum of 7 feet between the bottom of the panel and the roadway.

D. Signs

Portable signs may be used when the duration of the work is less than 3 days or as allowed by other conditions in the proposal. Ensure that all portable signs and sign mounting devices used in work meet the requirements of and are listed on the Department's QPL or Standard Drawings. When not being used, remove portable signs from the clear zone. Do not turn signs sideways or backwards while the signs are in the clear zone. Mount portable interim signs a minimum of 1 foot above the level of the edge of traveled way and at the height recommended by the manufacturer's crashworthy testing requirements.

All regulatory sign blanks shall be rigid.

Make every effort to eliminate the use of interim signs as soon as the Work allows for the installation of permanent signs.

Maintain existing street name signs at street intersections.

Cover all signs or portions of a sign(s) that are not applicable to the Traffic Control Plan so as not to be visible to traffic, or remove such sign(s) from the roadway when not in use.

Do not remove existing signs and supports without the Engineer's prior approval. Store and protect all existing signs and supports that are to be removed if this material will be required later in the Work.

Furnish, install, reuse, and maintain interim guide, warning, or regulatory signs required to direct traffic in accordance with the MUTCD. Mount the bottom of all interim signs at least 7 feet above the level of the pavement edge when the signs are used for long-term stationary operations as defined in the MUTCD.

Maintain existing guide and exit directional signs on the Project until conditions require a change in location or legend content. When change is required, the signs shall be in accordance with the Traffic Control Plan. When an existing guide and exit directional sign is in conflict with work to be performed, remove the conflicting sign and reset it in a new, non-conflicting location that has been approved by the Engineer.

When it is not possible to use existing signs, either in place or relocated, furnish, erect, maintain, modify, relocate, and remove new interim guide and exit directional signs as shown on the Plans or as directed by the Engineer.

Complete the installation of new permanent guide and exit directional signs, and the permanent modification or resetting of existing guide and exit directional signs, when included in the Contract, as soon as practicable to minimize the use of interim guide and exit directional signs.

E. Worker Visibility and Safety

Ensure that all workers within the Project's right-of-way, who are exposed to either vehicular traffic or to construction equipment in the work area, wear high-visibility safety apparel. Consider high-visibility apparel to be personal protective clothing that meets performance Class 2 or Class 3 of the ANSI/ISEA 107 publication. Provide Class 3 apparel for night work.

F. Portable Barrier Rail

Place all portable barrier rail as far away from the travel lanes as possible while serving the intended purpose. Move or remove all portable barrier as directed by the Engineer. The Department will make no additional payment for removing barrier that is no longer required.

G. Lane Closures

Hold the length of a lane closure to the minimum length required to accomplish the Work. Locate advanced warning signs for the Project so as to not overlap with the advanced warning signs for lane shifts and lane closures.

Use drums in all transition tapers for lane closures on multi-lane roads.

Contractor's Staff performing a lane closure shall have certifications that meet the requirements in Table 712.04-1 to close lanes on TDOT facilities and shall be onsite during each lane closure performed.

Table 712.04-1: Lane Closure Certification Requirements

Type of Facility	Requirement
Two Lane	Flagging Operations Certification (Shall comply with **712.04.A**)
Multi-Lane	*ATSSA Traffic Control Technician Training or equivalent
Controlled Access Freeways & Expressways	*ATSSA Traffic Control Technician Training or equivalent

* Proof of certification shall be provided to the Engineer at the Pre-Construction Meeting.

H. Night Work Lighting

When the Contract requires night work, supply sufficient lighting and equipment as specified herein.

1. **Lighting Plan.** Submit the following information regarding the lighting plan to the Engineer:

   a. Descriptions and sketches of the layout of lighting devices including spacing, luminary height, lateral placement, and anticipated illuminance provided.

   b. Photometric and physical specifications of all lighting equipment.

   c. Detailed description of all lighting to be used on construction equipment.

   d. Methods to be employed to reduce glare.

   e. Contractor's frequency and procedure for checking illumination levels.

2. **Protective Equipment and Lighting.** In addition to their standard protective equipment, equip construction personnel and equipment as follows:

a. Traffic Control Persons, all equipment operators, and all other workers shall:

   (1) Wear high-visibility apparel that meets performance Class 2 or Class 3 of the ANSI/ISEA 107 publication. Class 3 apparel shall be required for night work.

   (2) Have a minimum of 12 square inches of reflective material added to their hard hats that is visible from all sides.

b. Also equip Traffic Control Persons with:

   (1) A flashlight complete with semi-transparent red cone, and

   (2) Radios or cell phones so that they may communicate with each other.

c. All workers shall receive specific training on night work operations.

d. All vehicles in the work area must operate rotating or flashing incandescent amber lights visible in 360 degrees around the vehicle.

e. All work vehicles including trucks must have red and white reflective tape applied to all sides such that it defines the outline of the vehicle.

Provide the equipment specified in Table 712.04-2 with non-glare balloon style lights or equivalent. The lights will be required on each piece of equipment in operation.

Table 712.04-2: Night Work Lighting Requirements

Equipment Type	Illuminance Requirement
Paver, Milling Machine, Material Transfer Devices	One 4000-watt assembly or two 2000-watt assemblies
Grader, Roller, Rumble Strip Machine, Shoulder Machine	One 400-watt assembly
Paint truck	One 400-watt assembly or a non-glare 300-watt floodlight assembly
Guardrail driver, stationary operation	One 4000-watt assembly or two 2000-watt assemblies or equipment light plant
Trail Vehicle	One 4000-watt assembly or two 2000-watt assemblies

A trail vehicle will be required to follow the last piece of equipment in a mobile operation (i.e. finish roller, pavement marking, etc.) depicting the beginning of the working area. In addition, ensure that portable lighting of at least 400 watts is available for the density testing inspector. The Engineer will determine the illuminance requirement for other vehicles not listed in Table 712.04-2. The Contractor may substitute a 400-watt metal halide lamp or equal approved by the Engineer for a 2000 or 400-watt balloon light assembly.

Locate and direct all luminaries in such a way to minimize glare to both motorists and work vehicles. If glare is noted from any travel path, adjust the lighting to reduce the glare to a level acceptable to the Engineer.

Replace non-functioning lamps immediately. Check the luminary aiming daily. Regularly clean the luminaries.

I. Specification Compliance

The Engineer will notify the Contractor of failure to comply with this Specification or the Plans. The safe passage of pedestrians and traffic through and around the temporary traffic control zone, while minimizing confusion and disruption to traffic flow, shall have priority over all other Contractor activities. Continued failure of the Contractor to comply with the requirements of the Traffic Control Standard Specification or Special

Provisions will result in non-refundable deductions of monies from the Contract for non-performance of Work as long as the deficiency remains.

Failure of the Contractor to comply with this Specification or take immediate correction actions required within 48 hours of written notice shall be reason for the Engineer to suspend all other work on the Project, except erosion prevention and sediment control and traffic control, to apply non-refundable deductions of monies from the Contract at a rate of $2,500 per calendar day per notice, and to withhold payment of monies due to the Contractor for any work on the Project until traffic control deficiencies are corrected. These other actions shall be in addition to the deductions for non-performance of traffic control.

712.05 Pavement Marking Removal

Remove conflicting pavement markings, in a manner acceptable to the Engineer, to prevent confusion to vehicle operators.

Remove final surface pavement markings by sand blasting, water blasting, or acceptable grinding methods that will cause the least possible damage to the pavement.

Remove intermediate surface pavement markings by sand blasting or water blasting, or other approved methods that will cause the least possible damage to the pavement. The following methods are acceptable for removing intermediate surface pavement markings: sand blasting using air or water, high pressure water, steam or superheated water, or mechanical devices such as grinders, sanders, scrapers, scarifiers, and wire brushes.

At no cost to the Department, repair damage to the pavement or surface resulting from pavement marking removal using methods and materials acceptable to the Engineer. The removal shall not result in what appears to be a line that conflicts with the current markings.

Accomplish traffic shifts on the final surface using interim traffic marking tape unless otherwise shown on the Plans.

Do not remove an existing pavement marking by painting over with black paint or asphalt.

When the method of removal causes sand or other material to accumulate on the pavement, remove the residue as the work progresses.

712.06 Temporary Centerline and Lane Marking

Unless otherwise specified, install temporary pavement marking as follows:

1. Provide 4-inch wide pavement marking line as shown on the Plans for projects that will have traffic maintained overnight. For temporary pavement line markings on intermediate layers of pavement, use reflective tape, reflectorized paint, and raised pavement markers, or a combination thereof as shown on the Plans or as required by the Engineer, and install to permanent standards before dark hours. Short, unmarked sections will not be allowed. The Department will measure and pay for these markings as Painted Pavement Marking (Line) in accordance with **716.08** and **716.09**. Preserve established no-passing zones, if any, on the existing pavement; if no-passing zones have not previously been established, establish them before beginning the work. Mark two-lane, two-way highways with 10-foot long center lines applied on 40-foot centers and appropriate no-passing barrier lines.

2. Where required on the completed permanent surface, for 10-foot lane lines, no-passing barrier line, and edge line, use reflectorized paint applied as specified in **716**.

3. Maintain pavement markings at no additional cost to the Department until they are covered by the subsequent paving course or the Project is accepted.

4. It will not be necessary to remove pavement markings except for markings that convey conflicting or incorrect information to the traveling public.

712.07 Maintenance

Assume full responsibility for the continuous and expeditious maintenance of all signs, barricades, temporary impact attenuators, and all other traffic control devices to meet the "acceptable" category as described in *Quality Guidelines for Temporary Traffic Control Devices and Features* published by ATSSA. Such maintenance will be considered a part of the original installation cost. Failure to maintain all traffic control devices so as to provide continuous safety to the public will be cause for suspension of construction operations until proper traffic control is re-established.

712.08 Adjustment to Plans

Maintain traffic through the Project in accordance with the traffic control plan and the MUTCD. To request a change to the traffic control plan, submit a plan revision request in writing to the Engineer for approval, with the requested change marked in red on the traffic control plans sheets. The Engineer may adjust the traffic control plan as deemed necessary to ensure the safety of the workmen and traveling public.

COMPENSATION

712.09 Method of Measurement

The Department will measure the following for payment:

1. Signs, including Vertical Panels, erected on suitable supports by the actual area in square feet installed, with no deductions made for corner radii.

2. Flexible Drums for channelizing traffic by the unit, per each, as determined by counting the maximum number of drums on a jobsite and in use at any one time. This shall be designated by making a notation such as "On October 29, 2013, there were 242 Flexible Drums in use. Pay quantity is 242 Each." This will not apply to phase construction projects. On phase construction projects, each phase is treated as a separate project to arrive at a final pay quantity. The highest number used on Phase I, plus the highest number used on subsequent phases, will constitute the final pay quantity.

3. Barricades by the linear foot for the type designated.

4. Delineators and Temporary Flexible Tubular Delineators by the unit, per each.

5. Warning Lights and Flashing Arrow Boards by the unit, per each for the type designated. Payment will be based on the maximum number in place at one time.

6. Portable Barrier Rail by the linear foot. Separate measurement will be made for the initial installation of portable barrier rail at each site that the rail is used on the Project as shown on the Plans or approved by the Engineer. No separate measurement will be made for

removing and resetting portable barrier rail on new alignment at the same site to provide for changes in traffic control required by the different phases of construction. The following conditions apply to measurements of portable barrier rail:

a. The sites on one directional roadway of a divided highway will be considered independently of the sites on the other directional roadway.

b. Each bridge for which portable barrier rail is shown on the Plans or approved by the Engineer will be a separate site.

c. Additional relocations of barrier rail due to safety of work zone or traffic, as established in the traffic control plans or as directed by the Engineer laterally up to 10 feet, will be paid at 10% of the interconnected portable barrier bid amount unless a separate item is in the proposal.

7. Portable Impact Attenuators based on the initial installation of each portable impact attenuator. No additional payment will be made for removal, moving, and reinstalling impact attenuators at other locations on the Project as directed by the Engineer. Payment will be based on the maximum number of portable impact attenuators in place at one time.

8. Temporary pavement marking line as described for Painted Pavement Marking Line in **716.07** regardless of whether the lines are painted, taped markings, or raised pavement markers, or a combination of the above as shown on the Plans or as required by the Engineer, except that Removable Pavement Marking (Line) will be measured by the linear foot of installed line.

Unless otherwise specified, the Department will not separately measure or pay for traffic cones, removal of pavement marking, and flaggers, as these items will be considered incidental to the lump sum item Traffic Control.

The Department will pay for THPs, but the Contractor is responsible for notifying the THP and the Engineer when work has been canceled within 2 hours of the scheduled start of work. If the THP is not notified of work cancellation and the THP elects to monitor/patrol the project for a maximum of 2 hours, the Department will deduct from the monies owed the Contractor an amount equaling the THP pay rate for 2 hours of work.

The Department will pay for Uniformed Law Enforcement Officers provided by the Contractor at the per hour invoice price of the officer's work plus 5%, not to exceed $60 per hour for the total hours present on the Project. No compensation will be made for drive time.

712.10 Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Traffic Control	Lump Sum
Portable Barrier Rail	Linear Feet
Portable Impact Attenuator	Each
Signs	Square Feet
Vertical Panels	Square Feet
Flexible Drums	Each
Temporary Barricades (Type)	Linear Feet
Removable Pavement Marking (Description)	Linear Feet

The lump sum payment for Traffic Control is full compensation for providing Temporary Workzone Lighting and all equipment, labor, and materials, and for furnishing flaggers and traffic cones, and for removing conflicting and incorrect pavement markings, as required, until Project completion.

Payment for Portable Barrier Rail is full compensation for all materials, installation, maintenance, and all incidentals necessary to complete the work.

Payment for Portable Energy Absorbing Terminals will be made at the contract price per Portable Energy Absorbing terminal, complete in place, with total payment based on the maximum number of portable energy absorbing terminals in place at one time as specified in **712.09**.

Payment for Signs and Vertical Panels is full compensation for providing sign panels with proper sheeting and legend, erecting on proper supports, furnishing all mounting hardware, covering when not in use, relocating, handling, and maintaining until Project completion.

Payment for Barricades is full compensation for materials, equipment, relocating, handling, maintaining, and all incidentals of the work.

Unless otherwise designated, all signs, barricades, and other traffic control devices covered by this section shall become the property of the Contractor

at the completion of the Project. The salvage value for these items shall be reflected in the contract unit price bid.

The Department will pay for 10-foot lane line/center line and solid barrier line as Painted Pavement Marking (Line) in accordance with **716.08**.

Payment for Removable Pavement Marking Line, 8-inch Barrier Line, Channelization Striping or Stop Line, is full compensation for the installation, maintenance, and removal of the marking line when it is no longer required.

Payment for Uniformed Police Officers is full compensation for providing the Officer, official law enforcement vehicle, all necessary equipment, and administrative costs associated therewith.