

S T A T E

O F

T E N N E S S E E

March 1, 2006

(Rev. 02-09-09)
(Rev. 08-10-09)
(Rev. 01-05-10)
(Rev. 05-09-2011)
(Rev. 10-31-2011)

Supplemental Specifications - Section 400

of the

Standard Specifications for Road and Bridge Construction

March 1, 2006

Subsection 407.02 Materials, Add the following at the end of this subsection:

When warm mix asphalt additive is used as described in subsection **918.09(B)**, it shall be added by approved blending equipment at the contractor’s mixing plant, or it shall be pre-mixed and delivered with the asphalt cement.

Subsection 407.03 (C) Replace the first paragraph with the following:

At least 14 working days prior to the scheduled start of production of any asphaltic paving mixture, the Contractor shall submit in electronic form(e-mail or on a floppy disk) a proposed Job Mix Formula and Laboratory Design, where applicable, prepared in accordance with the Marshall Method of Mix Design (AASHTO R-12), as modified by TDOT, or by Gyratory Compaction (AASHTO T 312, Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by means of the Superpave Gyratory Compactor). Regardless of which method is used, trial blends with at least 4 different asphalt contents (at least 2 above the optimum and 2 below the optimum) shall be made. When the gyratory method of compaction is utilized, the specimens shall be compacted to 65 gyrations with the optimum asphalt content and mixture volumetrics determined at that compaction level. If the specification requirements are not met, it will be necessary to make adjustments to the aggregate types and proportions. In addition the Contractor shall submit an asphalt barge certification with temperature-viscosity curve for each mixture to the Engineer for approval. A sample of each material to be used in the mix shall be delivered to the location designated by the Engineer.

Subsection 407.03 (D) 2 (c) Quality Control System: 8 d Insert as the second sentence

“The Contractor, at his risk, may continue to produce and place mixture after the first 500 tons without the test results complete, however all mixture subject to price adjustment or removal at the discretion of the Engineer if the test results do not comply with the specifications.”

Subsection 407.03 (D), first paragraph, fourth sentence: Remove “on a random basis”.

Subsection 407.03 (D) 2 (c) Quality control System, 6, last sentence: Remove “on a random basis”.

Subsection 407.03 (D), Table 407-01, Replace “Required” with “Recommended” in the table heading.

Subsection 407.04a Bituminous Mixing Plant, Add the following to subsection “a” as the 12th bullet:

12. Warm Mix Asphalt process equipment.

Modifications may be made to plants to reduce production and placement temperatures in accordance with subsection 407.21. Plant modifications for warm mix asphalt production temperatures shall be pre-approved by the department, and shall not detriment the plant’s ability to maintain temperature control or mixture proportions.

Modifications made to the plant to reduce mixing temperatures must meet the requirements listed for warm mix asphalt additives in the department’s QPL.

Subsection 407.06-Bituminous Pavers: replace second sentence with:

“All paver extensions shall be full assembly extensions, including activated and heated screeds, auger extensions, auger guards, and throw-back blades to place mix beneath the auger gearbox.”

Subsection 407.09 Replace subsection in its entirety with the following:

407.09 Weather Limitations. Bituminous plant mix may be placed on properly constructed and accepted sub-grade or previously applied layers provided the following conditions are met:

1. The sub-grade and the surface upon which the bituminous plant mix is placed shall be free of excessive moisture.
2. The bituminous plant mix shall be placed in accordance with the temperature limitations of the following table and only when weather conditions otherwise permit the pavement to be properly placed, compacted and finished.

TEMPERATURE LIMITATIONS

| Compacted Thickness | Minimum Air or Surface Temperature | |
|--|------------------------------------|--------------------------------|
| | Unmodified mixes (PG 64, 67) | Modified mixes (PG 70, 76, 82) |
| 1.5 in. (40 mm) or less | 45° F (7° C) | 55° F (13° C) |
| > 1.5 in. (40 mm) to < 3.0 in. (75 mm) | 40° F (5° C) | 50° F (10° C) |
| ≥ 3.0 in. (75mm) | 35° F (2° C) | 45° F (7° C) |

- 3. No bituminous plant mix, with a compacted thickness of 1.5 in. (40 mm) or less, shall be placed between November 30 and April 1; and further, no bituminous plant mix, with a compacted thickness greater than 1.5 in. (40 mm), shall be placed between December 15 and March 16.
- 4. The contractor may request for approval a variance from the above required temperature and seasonal limitations to pave at lower temperatures when there is a benefit to the public. The request shall be in writing, be submitted at least one week prior to the anticipated need, and must include a "Paving and Compaction Plan for Cold Weather" in accordance with the TDOT Procedure. The plan shall identify what practices and precautions the contractor intends to utilize to assure 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. Practices that should be considered include the addition of rollers, reduced production and paving rates, insulated truck beds, and heating the existing surface.

If the Contractor cannot obtain the specified densities, then all paving operations shall cease and a new plan shall be developed. All mixture failing to meet specifications will be subject to price adjustments or removal and replacement at the Contractors expense.

Subsection 407.11 Preparation of Bituminous Material, Replace entire subsection with the following:

407.11-Preparation of Bituminous Material.

- A. **Hot Mix Asphalt (HMA).** The bituminous materials for hot mixes shall be heated to the required mixing temperature in accordance with the following **Table B**:

Table B

| PG Binder Grade | Minimum Temp. | Maximum Temp. |
|---------------------------|----------------------|----------------------|
| PG 64-22, PG 67-22 | 270° F(132° C) | 310° F(154° C) |
| PG 70-22 | 290° F(143° C) | 330° F(166° C) |
| PG 76-22 | 290° F(143° C) | 330° F(166° C) |
| PG82-22 | 290° F(143° C) | 330° F(166° C) |

The temperature for Grading AS and Grading ACRL mixtures shall be between 225 and 275° F(110 and 135° C), except when modified binders are used, and then the temperatures shall be between 275 and 330°F (135 and 166°C). Aggregate should be coated and no visible drain down should occur in storage silos or hauling equipment."

- B. **Warm Mix Asphalt (WMA).** The produced mixture may be subjected to reduced production and placement temperatures by means of either the addition of a chemical warm mix additive in accordance with subsection **918.09(B)** or by use of plant modifications in accordance with subsection **407.04(a)**.

When either WMA technology is utilized, the maximum mixing temperature for any grade of asphalt cement shall be no more than 300°F (135°C). At the beginning of a day's production, the producer may produce up to five truckloads at temperatures in accordance with Table B in order to pre-heat placement equipment (pavers, transfer devices) prior to

producing WMA. The laboratory mixing and compaction temperatures shall be stated on the job mix formula during the mix design approval process. A tolerance of ±5.0°F (2.8°C) for each temperature will be allowed.

During test strip construction, the plant-produced WMA must exhibit the ability to meet test requirements for tensile strength ratio (TSR), conditioned tensile strength, Marshall Stability and flow, and boil test listed for HMA in specifications **307, 407, and 411.**

Subsection 407.15 Following the eighth paragraph, Chart on **Density Requirements**, third column, Replace the word “number” with the word “No”

Subsection 407.15 To the Section “Any ADT”, Shoulder Mix include **B, BM & BM2** mixes.

Any ADT

| | | |
|---|-------|------|
| Shoulder Mix (B, BM, BM2, D, or E) | 88 | 85 |
| A S and A-CRL | None* | None |
| CS | None* | None |

Subsection 407.15, Replace the 12th paragraph which begins “It is intended...” with the following paragraph:

Acceptance test must be selected randomly and be representative of the lot or subplot. Additional compaction after the acceptance test is acceptable but the original test result must be used to determine lot density. TDOT may take information only samples to spot check compaction. These tests shall not be used as acceptance test.

Subsection 407.20 B 1, Remove and replace the Quantity/Sublot Table with the following:

| <u>Quantity</u> | <u>Number of Sublots</u> |
|--------------------|--------------------------|
| 3001-4500 tons | 4 tests |
| 2001- 3000 tons | 3 tests |
| 501-2000 tons | 2 tests |
| Less than 500 tons | 1 test |

Subsection 407.20 B 3 (b), Add the following as the first sentence:

Washed gradation of the residual aggregate shall be performed according to AASHTO T-30.

Subsection 407.20, Table 407-2, Revise table to the following:

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

TABLE 407-2

| ACCEPTANCE SCHEDULE OF PAYMENT (Asphalt Plant Mix Characteristics) | | | |
|--|-------------------|---|--------------------|
| Characteristics | Pay Factor | Average Arithmetic Deviation of the Lot Acceptance Test from the Job Mix Formula | |
| | | 1 Test | 2 Tests or more |
| Asphalt Cement | 1.00 | 0.00-0.30 | 0.00-0.25 |
| Content *** | 0.95 | 0.31-0.35 | 0.26-0.30 |
| (Extraction or ignition oven) | 0.90 | 0.36-0.40 | 0.31-0.35 |
| | 0.80* | over 0.40 | over 0.35 |
| Gradation | | | |
| 3/8 In. (9.5 mm), 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* | over 7.66 | over 6.69 |
| Gradation | | | |
| No. 4 Sieve** (4.75 mm) | 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* | over 5.77 | over 5.00 |
| Gradation | | | |
| No. 8 16, 30 & 50 (2.36 mm, 600 µm & 300 µm ,) Svs** | 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* | over 5.12 | over 4.52 |
| Gradation | | | |
| No. 100 & 200 (150 µm & 75 µm) Sieves** | 1.00 | 0.00-1.80 | 0.00-1.60 |
| | 0.90 | 2.01-2.20 | 1.76-1.90 |
| | 0.95 | 1.81-2.00 | 1.61-1.75 |
| | 0.80* | over 2.20 | over 1.90 |

*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 has the option to remove and replace at no cost to the Department at any time.

Subsection 411.03 Composition of Mixtures, Replace entire subsection with the following:

411.03-Composition of Mixtures.

- (a) General Composition of mixtures used in this construction shall meet all applicable requirements of Subsection 407.03.

(b) The specified mineral aggregate and asphalt cement shall be combined in such proportions as to produce mixtures within the following master composition limits.

Proportions of Total Mixture, Per Cent by Weight

| Surface Courses | Effective Combined Mineral Aggregate | Asphalt Cement |
|------------------------------|---|-----------------------|
| Grading D | 93.0- 94.3 | 5.7-7.0* |
| Grading E | 93.0- 94.3 | 5.7-7.0* |
| Grading E (shoulders) | 92.0-94.7 | 6.0-6.5* |

*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.

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 shall have:

All Roads

| Mix | Stabil. Min. lbft* (kN) | Flow 0.01 in. (mm) *** | Design Void content t%* | Production Void Content %* | Min. VM A% * | Dust-Asphalt Ratio* * |
|-------------|--------------------------------|-------------------------------|--------------------------------|-----------------------------------|---------------------|------------------------------|
| 411D | 2,000 (9.0) | 8-16 (2-4) | 4.0±0.2 | 3-5.5 | 14 | 0.6-1.2 |

*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.

**The dust to asphalt ratio is the percent of the total aggregate sample that passes the 200 mesh(75 µm) sieve as determined by AASHTO T 11 divided by the percent asphalt in the total mix

***Flow will only be required when using a non-modified binder (PG 64-22 or 67-22)

****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%.

When limestone screenings or agricultural limestone are utilized, the maximum amount by weight of the mineral aggregate shall be 25% unless the material is shown to meet the same coarse surface aggregate requirements for limestone as listed in **Subsection 903.11 (c) Grade D** (Types I, II, III, IV). In no case shall the combined aggregate blend consist of less than 75% non-skid material. When natural sand is used as

fine aggregate, it shall be limited to a maximum amount of 25% by weight of the mineral aggregate. A maximum of 5% mineral filler meeting the requirements of **Subsection 903.16** may be substituted for an equal quantity of the limestone fines. If the mixture does not comply with the design criteria, another source of aggregate shall be required.

When gravel is used as the coarse aggregate for a 411 Grading D mix, a minimum of 20% by weight limestone screenings, agricultural limestone and/or mineral filler shall be required.

Grading E

In addition to the other requirements of these specifications where Grading E is used for the riding surface the composition of the mineral aggregate shall be such that when combined with the required amount of bitumen the resultant mixture shall have:

High Volume Roads (ADT over 1,000)

| Mix | Stability Min. lbft* (kN) | Flow 0.01in. (mm) ** | Design Void content %* | Production Void Content %* | Min. % VMA * |
|------------------|------------------------------------|-------------------------------|---------------------------------|-------------------------------------|-----------------------|
| 411 E | 2,000 (9.0) | 8-16 (2-4) | 4.0±0.2 | 3-5.5 | 14 |

Low Volume Roads (ADT 1,000 and below)

| Mix | Stability Min. lbft* (kN) | Flow 0.01in. (mm)** | Design Void content %* | Production Void Content %* |
|------------------|------------------------------------|---------------------------|---------------------------------|-------------------------------------|
| 411 E | 1,500 (6.75) | 8-16 (2-4) | 3.5±0.5 | 2-5 |

*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.

**Flow will only be required when using a non-modified binder (PG 64-22 or 67-22)

*** Minimum stability for shoulder mixes will be 1500 lb.ft. (kN) and optimum Asphalt Cement content for shoulder mixes shall be as directed by the Regional Materials Supervisor.

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

(c) Recycled Asphalt Pavement

The Contractor may utilize asphalt pavement that has been removed from a Department project or other State Highway Agency project by an approved method and stored in a TDOT approved stockpile. Recycled Asphalt Pavement (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 of **Subsection**

903.11 and the requirements herein **Section 411**. RAP shall be allowed in each mix listed in the following table:

| Mix Type | %RAP (Non-processed) | Maximum %RAP (Processed) | Maximum % RAP Processed and Fractionated | Maximum Particle size |
|------------------------|----------------------|--------------------------|--|-----------------------|
| 411D(PG64-22, PG67-22) | 0 | 15 | 20 | ½ in. (12.5 mm) |
| 411D(PG70-22) | 0 | 10 | 15 | ½ in. (12.5 mm) |
| 411D(PG76-22, PG82-22) | 0 | 10 | 15 | ½ in. (12.5 mm) |
| 411E(Roadway) | 0 | 15 | 20 | ½ in. (12.5 mm) |
| 411E(Shoulder) | 15 | 30 | 35 | ½ in. (12.5 mm) |

RAP that has been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that listed in the table above prior to entering the dryer drum, shall qualify as “Processed”. “Non processed” RAP shall be similar material that has not been crushed and screened or otherwise sized previous to its use. When RAP is processed over more than one screen, producing sources of various maximum particle size (i.e. – ¾” to ½”, ½” to #4, etc.), it will be referred to as “fractionated”, and larger percentages will be allowed as noted above. These increased percentages will only be allowed provided the individual fractions 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.

The Contractor shall obtain a representative sample from the recycled material stockpile and establish a gradation and asphalt cement content as required. The Contractor shall determine the gradation and asphalt content of the recycled material at the beginning of a project and every 2,000 tons (2,000 metric tons) thereafter. The stockpile asphalt cement content for all recycled material shall not vary from the Job Mix Formula by more than ± 0.8 %. The stockpile gradation tolerance for all recycled material on each sieve is listed below.

- 3/8in. (9.50 mm) sieve and larger± 10%
- No. 4(4.75 mm) sieve.....± 8%
- No. 8(2.36 mm) sieve.....± 6%
- No. 30(600 µm) sieve.....± 5%
- No. 200(75 µm) sieve.....± 4%

The Contractor will be responsible for his own sampling and testing of the RAP as well as new materials for bid purposes, and for the submission of the job mix formula in accordance with **Subsection 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 mixture will be accepted for aggregate gradation and asphalt content based on extractions or in accordance with AASHTO T 308

(d) Anti-Strip Additive

Asphaltic concrete surface mixtures (Grading D & E) shall be checked for stripping by the Ten Minute Boil test for dosage rate and ASTM D 4867(Root-Tunnecliff procedure) for moisture susceptibility.

If moisture susceptibility is indicated, then an approved anti-strip agent shall be mixed with the asphalt cement at the dosage recommended by the respective test and as specified in **Subsection 918.09(B)**.

Subsection 411.09-Method of Measurement. Remove and replace the entire subsection with the following:

Subsection 411.09-Method of Measurement. Mineral Aggregate including Mineral Filler, when required, and Asphalt Cement for Asphaltic Concrete Surface (Hot Mix) will be measured as prescribed in Subsection 407.19. Mineral Filler when required will not be measured for payment separately, but will be included as mineral aggregate.

If recycled mix is permitted, the completed mix, including new mineral aggregate, planings, asphalt cement and additive, shall be measured by the ton (tonne) in accordance with Section 109. For bidding purposes, the asphalt cement content of the specified mix shall be used in the chart below:

| Mix Type | Asphalt Content |
|----------------|-----------------|
| 411-D | 5.9% |
| 411-E Roadway | 6.3% |
| 411-E Shoulder | 6.3% |

In the event that the Engineer sets an asphalt content other than that stated above, a price adjustment will be made 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 price adjustment will be calculated according to the following formula:

$$PA = [MBI \times (DA-BA) \times T]/100$$

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 (metric tons) asphalt mix for price adjustment

The liquid anti-strip additive will be measured by the gallon(liter) and paid as outlined in Subsection 411.10. Hydrated Lime will be measured by the ton(metric ton) and paid as outlined in Subsection 411.10.

No direct payment will be made for polymer or latex additives and cost thereof shall be included in the price bid for the modified asphalt cement or modified mixture.

Subsection 414.03, Revise entire section as follows:

414.03-Composition of Mixture. At least 2 weeks prior to beginning work the Contractor shall submit a signed original of a mix design 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. The samples should contain information relative to sources, type of materials and project number.

This design must have been performed by a qualified laboratory. Once the materials are approved, no substitution will be permitted unless first tested and approved by the laboratory preparing the mix design. No work shall begin nor will any mixture be accepted until the Materials and Tests Division has evaluated and accepted the mix design.

The laboratory report will show the results of tests performed on individual materials, comparing their values to those required by this specification. Job aggregates will be used in all laboratory design tests. Mixing tests must pass at the maximum expected air temperature in ISSA T113.

Slurry Seal. The laboratory report will provide the following information on the slurry seal mixture.

Quick-Set Emulsified Asphalt Slurry Seal

| | |
|--|------------------|
| Mixing Time Test, seconds @ 77° F(25° C) (TB #113), | 120 minimum |
| Mix Time @ (50° and 100° F) (10° and 37.7° C) | (informational) |
| Set Time Tests | |
| 30-Minutes-Blotter Test (TB #102) | no brown stain |
| Displacement Test | no displacement |
| Water Resistance Test @ 30 minutes (TB #102) | no discoloration |
| Wet Stripping Test, % coating (TB #114) | 90% minimum |
| System Compatibility (TB #115) | Pass |
| Set Time Tests: 30 minutes (TB #139) | 12 kg-cm minimum |
| Early Rolling Traffic Time: 2 hours (TB #139) | 20 kg-cm minimum |

| | |
|---|-------------------------------|
| Wet Track Abrasion Test, loss in g/ft ² (g/m ²) (TB #100) | 75(800) maximum 6 day soak |
|---|-------------------------------|

In addition to the tests specified above, the following test will be required on roadways having greater than 1500 ADT.

| | |
|-----------------|--|
| ISSA T #109 | Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion |
| 1,500-3,000 ADT | Maximum 55grams/psf (590g/m ²) sand adhesion, 1,000 cycles @ 125 lbs. (57 kgs). |
| 3,000+ ADT | Maximum 50grams/psf (540g/m ²) sand adhesion, 1,000 cycles @ 125 lbs.(57 kgs). |

Slurry Seal Composition. Emulsified asphalt slurry seal shall be a uniform mixture of aggregate, emulsified asphalt, latex solids when specified on the Plans, mineral filler and water. Compatibility of all ingredients (including the mix set additive) of the mix shall be certified by the emulsified asphalt manufacturer.

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 $\pm 0.50\%$.

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

Portland cement may be added to obtain the desired dispersion and working characteristics of the slurry. Such addition shall be stated on the slurry seal design, shall not exceed 3% of the weight of the aggregate, and shall have a mixture control tolerance of $\pm 0.25\%$.

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.

The aggregate shall be prewetted with a minimum amount of water prior to blending with the emulsified asphalt to obtain a fluid, homogeneous slurry mixture of the proper consistency. No additional water above that quantity required by the slurry seal mix design shall be added to the slurry mix in order to obtain a more workable mixture.

Micro Surfacing. The laboratory report will provide the following information on the micro-surface mixture.

| | |
|---|------------------|
| Mixing Time Test, secs @ 77° F (25° C), (T-102) | 120 minimum |
| Mix Time @ 50 and 100° F (10° C and 37.7° C) | (informational) |
| Set Time Tests: 30 minutes (T-139) | 12 kg-cm minimum |

| | |
|--|--|
| Early Rolling Traffic Time: 60 minutes (T-139) | 20 kg-cm minimum |
| Wet Stripping Test, % coating (T-114) | 90% minimum |
| Wet Track Abrasion Test, loss in g/ft ² (g/m ²) (T-100) | 75 (800) max 6 days 50 (538) max. 1 hour |
| Measurement of Excess Asphalt (T-109) | Max. 50 grams/ft ² (540 grams/m ²) Sand Adhesion, 1,000 Cycles @ 125 lbs. (57 kgs). |
| Classification Compatibility (T-144) | 11 pt. minimum |

Micro-Surface 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 represent material to be used on the project.

The Engineer shall approve the design prior to use. Proportions for the design shall be within the following limits:

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

Portland cement may be added to obtain the desired dispersion and working characteristics of the mix. Such addition shall be stated on the micro-surface design, shall not exceed 3% of the weight of the aggregate, and shall have a mixture control tolerance of $\pm 0.25\%$.

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.

The mixture shall also be proportioned such that the test strip requirements in **Subsection 414.06** are achieved.

Applicable Specifications. The following specifications and test methods form a part of this specification.

| 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 | ISSA TB-139 |

| | |
|---|-------------|
| of Set and Cure Characteristics | |
| Classification Compatibility | ISSA TB-144 |
| Design, Testing and Construction of Micro-Seal | ASTM D 3910 |
| Quantitative Extraction of Bitumen for Bituminous Paving Mixtures | ASTM D 2172 |

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

1. Be capable of filling up to ½ in. (13 mm) wheel ruts in one pass.
2. Be capable of field regulation of the setting time.
3. Be suitable for nighttime placement.

Subsection 414.04, Revise subsection as follows:

414.04-Equipment. All equipment necessary for the satisfactory performance of this work shall be on hand and approved before the work is permitted to begin. All equipment, tools, and machines used in the performance of this work shall be maintained in satisfactory working condition. The Contractor shall have available at all times a device capable of determining aggregate moisture within 3 minutes.

All trucks shall be covered immediately after loading with a cover of canvas or other suitable material. The cover shall lap down along the sides and rear of the truck bed a minimum of 6 in. (150 mm) and be secured by tie downs at a maximum of 5 ft. (1.5 m) spacing along the sides and rear of the truck bed. All trucks must be equipped to meet the above requirements prior to commencing hauling operations.

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

Mixing Equipment. The mixing equipment shall be re-supplied with all materials while depositing the mixture on the roadway in order provide a continuous, non-stop surfacing operation. The paving mixture shall be produced 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.

The mixing machine shall be equipped 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. A spray bar shall be provided 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 in. (1.25 m) long. The emulsion shall be introduced 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.

Mixing shall be done 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.

The mixer shall be equipped 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. Effective April 1, 2006, the Contractor shall 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. The mixer shall be equipped with a back-up electronic materials counter that is capable of recording running count totals for each material being monitored. The mixer shall be equipped with a radar ground measuring device. Each material control device shall be calibrated prior to each mix application and as often thereafter as deemed necessary by the Engineer. The computer system shall have the capability to record, display and print the following information:

- Individual sensor counts for emulsion, aggregate, cement, water and additive
- Aggregate, emulsion, and cement output in lbs.(kgs) per minute
- Ground travel distance. The mixer shall be equipped with a Radar Ground metering device
- Spread rate in lbs./s.y.(kgs/m²)
- Percentages of emulsion, cement, water and additive
- Cumulative totals of aggregate, emulsion, cement, water and additive
- Scale factor for all materials

The computer system shall be functional at the beginning of work, and must be functional during each calibration.

The mixing machine shall be equipped with a water pressure system and fog type spray bar, adequate for complete fogging of the surface preceding spreading equipment of the mixture.

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

The emulsion pump shall be of the positive displacement type and shall be equipped with a device so that the amount of emulsion used may be determined at any time. The emulsion pump, meter and piping shall be arranged to afford a means to calibrate 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.

The water pump shall be equipped with a minimum of 2 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.

The mixing machine shall be equipped with approved metering devices so that it can be accurately calibrated and the quantities of materials used during any 1 period can be closely estimated. In the event that the metering devices stop working properly, the mixing machine shall no longer be used until necessary repairs have been made.

Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of emulsion from the pump. Each mixing unit shall be

calibrated in the presence of the Engineer prior to construction. The documentation shall include an individual calibration of each material at various settings, which can be related to the machine's metering devices. When calibrating the emulsion system, a minimum of 3 tests shall be run, with each test run being a minimum of 40 gal. (150 liters). Calibration of the aggregate delivery system shall require tests at 3 different gate settings with 2 test runs at each gate setting and a minimum of 425 lbs. (193 kgs) per test run. Calibration of the filler(cement) delivery system shall require 3 tests at a minimum of 25 lbs. (11 kgs) per test. The scales used shall be certified. No machine will be allowed to work on the project until the calibration has been completed and accepted. Additional calibrations may be required during the process of the work as directed by the Engineer.

Spreading Equipment. Attached to the machine shall be 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 attached to the mixer, equipped with ribbon flights mounted on an adjustable shaft to continually agitate and distribute the materials throughout the box. The box shall be equipped with curb bumpers and replaceable runners with a minimum of 5 ft. (1.5 m) long end runners. The box shall be equipped with 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 crossbracing for rigidity and a manufacturer's weight not less than 1,400 lbs. (635 kgs) at a width of 12 ft. (3.6 m). The box must be capable of laying mix to a width of 14 ft. (4.3 m). 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 the loss of the mixture from the box, the Contractor shall attach flexible seals, front and rear, in contact with the road. The full width application box shall be equipped with a secondary strike-off located approximately 2 to 3 ft. (0.5 to 1.0 m) 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. A rut box shall be used for filling ruts in excess of 3/8 in. (10 mm) unless otherwise specified on the plans. The Contractor shall operate the spreading equipment in such a manner to prevent the loss of the mixture on super-elevated curves. Mixture shall be spread 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, shall require approval by the Engineer. Drags having excessive build-up shall be replaced. Drags shall be kept in a completely flexible condition at all times. No drags shall be used on Micro-surfacing.

Subsection 414.06, Revise subsection as follows:

414.06-Application. Prior to the placement of the mixture, a tack coat of CQS-1h or CQS-1hp emulsion shall be applied with an asphalt distributor. The tack coat shall consist of 1 part emulsion and 2 parts water. The application rate shall be 0.05 to 0.10 gal./s.y.(0.2 to 0.5 liters/m²) of the diluted emulsion. The actual application rate shall be determined by the Engineer. The method of application of the tack coat shall be in accordance with **Section 403**.

The emulsified asphalt slurry seal shall be applied at a rate of 16 ± 2 lbs./s.y. (of 8.75 ± 1 kgs/m²) based on dry aggregate weight unless otherwise specified on the Plans. The rate of application shall be varied within the range specified above as required by the condition of the pavement to obtain a minimum thickness of 1/8 in. (3 mm) above the high points of the milled areas and 1/4 in. (6 mm) thickness on unmilled areas.

Micro-surface shall be applied as follows:

- Rutfill 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 in. (3 mm) after 24 hours of traffic compaction. Apply rut fill courses in widths from 5 to 6 ft. (1.5 to 1.8 m) for each wheel path. Provide a smooth, neat seam where 2 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.
- Leveling Course. If a leveling course is specified, apply at a rate of 14 ± 2 lbs /s.y. (7.6 ± 1.1 kgs/m²) based on dry aggregate.
- Surface Course. If a surface course is specified and it is placed over a leveling course, apply at a rate of 18 ± 1 lbs/s.y. (8.7 ± 0.6 kgs/m²) 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 lbs/s.y. (11.9 kgs/m²) based on dry aggregate.

Micro-surface shall be applied at the rates as specified on the plans for leveling and surface courses.

The mixture shall be applied based on dry aggregate weight as specified on the plans.

The maximum allowable speed of the machine shall be 130 ft. (40 m) per minute. When rut filling, the maximum allowable speed shall be determined by the Engineer. The final surface seal shall be placed uniformly across the width of the traffic lane unless otherwise specified or directed. The action of the squeegee shall permit the mix to flow freely leaving a smooth, uniformly textured surface.

Unless otherwise directed by the Engineer, the surface shall be pre-wetted with water by fogging ahead of the spreader box. Pre-wetting shall be closely controlled to prevent accumulation of water 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, the aggregate shall be given a final screening by sieving it through screening equipment capable of removing any random oversize material.

The mixture shall be of the desired consistency when deposited on the surface after which no additional elements shall be added. A sufficient amount of mixture will be carried in all parts of the spreader at all times so the complete coverage is obtained. No lumping, balling or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the mix will be removed from the pavement. The mixture shall have proper consistency so that excessive splattering and excessive free water is avoided. The spraying of water into the spreader box during lay down operations will not be permitted. Hand tools, lutes and squeegees shall be used to spread mix on areas not accessible to the machine spreading equipment. Rolling with a pneumatic-tired roller shall be required after proper curing for sections of pavement not to

be exposed to traffic. The roller shall be equipped with tires with a pressure of 40-60 psi(275 to 425 kPa).

Quality Control: The Contractor shall produce a mixture that will be in compliance with the mix design and the quality control tolerances. The Slurry Seal or Micro-Surface shall be applied at the rates as specified on the plans. The methods described in this section shall be used by the Contractor to measure compliance. Contractor shall maintain all quality control documentation and make available to the Engineer or Project Inspector upon request or at completion of work.

- a. Asphalt Content – The Contractor shall calculate the % asphalt content of the mixture from the equipment computer display readings randomly, a minimum of 3 times a day. The quality control tolerances from the mix design is $\pm 0.5\%$.
- b. Application Rate – The Contractor shall calculate the yield of the course being placed from the equipment computer display readings randomly, a minimum of 3 times a day. The quality control tolerance from the specified application rate is ± 2 lbs/s.y. (± 1 kg/m²).
- c. Documentation – The Contractor shall maintain a daily report and a lot sheet as follows:
 1. Daily Report – The daily report shall include the following information:
 - Aggregate used, ton(metric ton) (dry)
 - Slurry or Micro-Surfacing emulsion used, ton(metric ton)
 - Bituminous Materials for Tack Coat and for Fog Seal, ton (metric ton)
 - Cement used, ton(metric ton)
 - Water used in mixture, gallons(liters)
 - Additive used in mixture, gallons(liters)
- d. Test Strip Construction - Prior to production application, the Contractor shall place a 1,000 ± 50 ft. (300 ± 15 m) test section to verify a quick traffic system is being used. The test strip shall be placed at the same time as paving is to take place, night or day, and under the same ambient conditions. The test strip shall be able to carry normal traffic within 60 minutes. If normal traffic cannot be carried, the emulsion or mixture must be adjusted and another test strip will be required.

Lot Sheet - The project shall be segmented into lots with any 1 lot not to exceed 20,000 s.y.(16,700 m²). For each lot the Contractor shall maintain a lot sheet, providing the following information:

- Control Section, Job Number, Route, Engineer (Project Inspector)
- Date, Air Temperature
- Control Settings, Calibration Values, Unit Weight of Emulsion (lbs per gallon) (kgs per liter), Percent residue in Emulsion.
- Beginning and Ending Intervals
- Computer display readings for material usage (Beginning, and Ending, and Total)
- Length, Width, Total Area (s.y.) (m²), (lbs.) (kg) of Aggregate, lbs. (kg) of Emulsion, lbs. (kg) of Cement.
- Percent of each Material, Percent of Asphalt Cement, Application Rate, Combined Application Rate (lbs./yd²) (kgs/m²)

- Mix Design (Percent Portland Cement, Percent Emulsion, Percent Asphalt Cement)
- Contractors Authorized Signature
- Calibration Forms

Subsection 414.09, Revise subsection as follows:

414.09-Weather Limitations. Micro-surface and slurry seal shall be placed only when the pavement surface temperature and the ambient air temperature are a minimum 50° F(10° C) and rising. These applications will not be placed during foggy or rainy conditions. Placement shall be limited to the period from April 1 to October 31.

Subsection 414.11, Revise the second paragraph to as follows:

For bidding purposes, the emulsified asphalt content on the slurry mix design shall be 15% and for micro-surfacing design the asphalt content shall be 12%. In the event that the Engineer sets an emulsified asphalt content for slurry seal other than that stated above, a price adjustment will be made 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 price adjustment will be calculated according to the following formula:

Subsection 415.02, (Delete the third paragraph) “When milling the Interstate...”