ATTACHMENT 4– CONSTRUCTION GUIDE SPECIFICATIONS FOR EMULSIFIED ASPHALT FOG SEAL

"*These Guide Specifications are the recommendation of the research for NCHRP Project 14-37 that was conducted by Shuler Consultants, LLC. The Guide Specifications have not been approved by NCHRP or any AASHTO committee; nor have they been formally accepted for the AASHTO specifications*".

SECTION 410
EMULSIFIED ASPHALT FOG SEAL

410.01 Description

This guide specification is intended to provide information needed for owners or contractors to construct emulsified asphalt fog seals. An emulsified asphalt fog seal is the application of emulsified asphalt, either diluted or undiluted, to a prepared pavement surface and may be followed immediately by a light application of blotter sand. Fog seals are intended as a barrier to air and water infiltration of a pavement surface, to arrest low severity raveling or to create color contrast between traffic markings and the paved surface.

This guide specification refers to quality requirements for materials and methods used to construct fog seals.

Commentaries are included in this Guide in places where added emphasis is needed to explain the section being discussed or when there are options to be considered by the user of the Guide, or, as sources of additional information.

A. Referenced Documents

1. AASHTO Standards:

   - M 140, Emulsified Asphalt
   - M 208, Cationic Emulsified Asphalt
   - T 27, Sieve Analysis of Fine and Coarse Aggregates
   - T 304, Standard Method of Test for Determining the Uncompacted Void Content of Fine Aggregate

2. ASTM Standards:

   - D 5624-13, Standard Practice for Determining the Transverse-Aggregate Spread Rate for Surface Treatment Applications

3. Other:

- Shuler, S. 1991, High Traffic Chip-Seal Construction: The Tulsa Test Road, *Transportation Research Record No. 1300*, National Academy of Sciences, pp 116-124.

B. Terminology

1. *CSS-1h* – a cationic emulsified asphalt that is slow setting and has a residual binder residue with lower penetration than CSS-1.

2. *SS-1h* – an anionic emulsified asphalt that is slow setting and has a residual binder residue with lower penetration than SS-1.

410.02 MATERIAL

A. Emulsified Asphalt

Emulsified asphalt for fog seals shall meet the requirements of AASHTO M140 or M208. Fog seal emulsified asphalt may be diluted 50:50 with water prior to application, but the residual asphalt content shall not be less than 50 percent by weight of the total mixture.

B. Aggregate

When blotter aggregate is used in fog seals, the aggregate shall meet the requirements of AASHTO T27. The aggregate size to be used will be as shown in the plans or other contract documents or the requirements shown in Table 1. Aggregate shall be crushed by mechanical means and shall have a minimum angularity of 45 as determined by AASHTO T 304.

Table 1 – Fog Seal Aggregate

Sieve Size, T27	Passing, %
No. 8	100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 200	0-10

Commentary

Blotter aggregate is sometimes used to absorb any excess asphalt emulsion that may occur on the pavement surface due to over application or because of pooling in low areas of the pavement.

410.03 CONSTRUCTION

A. Weather Limitations

Construct fog seal per the following conditions:

1. Ambient or pavement surface temperatures shall be 60F (15C) and rising.
2. Application of the fog seal shall be only during daylight hours.
3. The road surface shall be dry
4. Suspend fog seal operations when rain is expected before the fog seal emulsion can set.
5. Temperatures below 40F are not anticipated for at least 24 hours after application.
6. Sustained winds are less than or equal to 10 miles (16 kilometers) per hour; and
7. Application is completed at least 2 hours before sunset.

B. Application Rate

The asphalt emulsion application rate for the fog seal shall be between 0.015 to 0.039 gal/yd^2 of residual asphalt binder. Target rates are shown in Table 2 for four types of typical pavement surfaces. The actual rate used for a specific pavement shall be determined using a test strip or by the ring test described below.

Table 2—Initial Target Fog Seal Application Rate

Surface Type	Residual Rate Gal/yd^2	Undiluted Gal/yd^{2*}	Diluted 1:1 Gal/yd^2
Dense-Graded Asphalt Mixture	0.015-0.021	0.025-0.035	0.05-0.07
Open-Graded Asphalt mixture	0.021-0.027	0.035-0.045	0.07-0.09
Chip Seal (<1/2 in. top agg size)	0.027-0.033	0.045-0.055	0.09-0.11
Chip Seal (≥1/2 in. top agg size)	0.033-0.039	0.055-0.065	0.11-0.13

**This assumes an emulsion residual binder content of 60% and a water content of 40%*

Ring Test:

1. Sweep the section of road to be fog sealed clean of debris and dust.
2. Draw three 6-in. diameter circles on the swept pavement.
3. Select three target application rates and translate them to the required volume of emulsified asphalt from Table 2.
4. Label each circle with its application rate.
5. Use a 10-ml graduated cylinder to pour the required amount of emulsified asphalt into the center of each circle. Evenly distribute the material within the circle.
6. The ideal application rate will evenly and completely cover the pavement within the circle, with no emulsified asphalt draining outside.
7. Record the optimal application rate.

Table 3—Amount of Emulsified Asphalt for Ring Test

gal/yd^2	ml (6-in. Circle)
0.05	4.2
0.06	5.0
0.07	5.8
0.08	6.6
0.09	7.4
0.10	8.3
0.11	9.1
0.12	10.0
0.13	12.8

All design work will be carried out using the emulsified asphalt to be used on the job site or from equivalent material from the same source and having substantially the same material properties.

Commentary

The ring test is especially recommended when the pavement surface to be fog sealed is tight and dense and excess emulsion could result.

C. *Preconstruction Meeting*

Coordinate a preconstruction meeting prior to construction with the engineer to discuss the following topics:

i. construction process
ii. quality control plan, required to be submitted
iii. mix design, required to be submitted

iv. materials control
v. materials measurement
vi. equipment calibration, required to be submitted
vii. traffic control plan
viii. equipment/process overview
ix. inspection
x. test strip
xi. unique project conditions
xii. project documentation
xiii. expectations

D. Road Surface Preparations

1. Cleaning Pavement

Clean the roadway surface by sweeping no more than 30 minutes prior to application of the asphalt emulsion fog seal. However, this 30-minute window may be extended if authorized by the engineer in cases where extending the time does not jeopardize a clean surface prior to fog seal operations. Sweep the pavement with a motorized broom to remove loose material. Clean depressions not reached by the motorized broom with a hand broom. Clean the outer edges of the pavement to be sealed including an adjacent paved shoulder.

2. Protecting Accessories

Cover utility castings (manholes, gate valve covers, catch basins, sensors, etc.) to prevent coating with emulsified asphalt. Suitable covering includes plywood disks, Kraft paper, roofing felt or other approved methods. Remove the protective coverings before opening the road to traffic.

E. Equipment

1. Pressure Distributor

The pressure distributor shall have a ground speed control device interconnected with the emulsified asphalt pump such that the specified application rate will be supplied at any speed. The pressure distributor shall be capable of maintaining the emulsified asphalt at the specified temperature. The spray bar nozzles shall produce a uniform double lap application fan spray, and the shutoff shall be instantaneous, with no dripping. All nozzles shall be oriented at the same angle between 15° and 30° using the wrench supplied by the distributor manufacturer and as described below in Equipment Calibration.

2. Blotter Sand Spreader

   If used, a self-propelled mechanical type aggregate spreader with a computerized spread control, capable of distributing the aggregate uniformly to the required width and at the designed rate shall be used. The spreader shall be a self-propelled type mounted on pneumatic-tired wheels.

3. Brooms

   Motorized brooms with a positive means of controlling vertical pressure shall be used to clean the road surface prior to spraying emulsified asphalt.

   Commentary

   Vacuum brooms are preferred in urban or residential areas, but push brooms are acceptable in rural areas where debris scattered off the roadway does not pose a hazard to pedestrians or vehicles.

4. Trucks

   Unless otherwise approved, use trucks of uniform capacity to deliver the aggregate.

F. Equipment Calibration

The contractor shall provide proof of calibration of the pressure distributor and the aggregate spreader if aggregate is applied to the fog seal. Calibration shall be repeated once per week or after every five full days of operations. The contractor shall submit the results of the calibration procedure to the Engineer.

Flow from each nozzle in the pressure distributor must be within +/-10 percent of the average flow of all nozzles as measured by the procedure described below.

Uniformity of the aggregate applied transverse to the pavement centerline in accordance with ASTM D5624, "Determining the Transverse Aggregate Spread Rate for Surface Treatment Applications". Tolerance for each pad tested for transverse spread rate shall be +/-10 percent of the average of the total transverse rate.

Commentary

Calibration is very important to assure the quantity of emulsion and blotter sand applied to the pavement is correct. Although many modern asphalt distributors and aggregate spreaders are computer controlled, calibration is required to tell the computer how much emulsion is being applied. This quantity must be checked prior to spraying emulsion and spreading blotter sand and checked against the quantity the computer (if the distributor is so equipped) indicates is being applied.

4. Pressure Distributor

All nozzles shall be the same size, provide the same flow rate, be oriented in the same direction, and be the same distance above the pavement.

Commentary: The distributor truck applies emulsified asphalt to the pavement surface. This application must be done uniformly both transverse and longitudinal to the centerline of the pavement.

When lower application rates are determined necessary or shown in the plans, smaller nozzles shall be inserted in the spray bar where the emulsion rate is reduced.

Commentary: Due to minor rutting or heavy truck traffic, it may be desirable to reduce the emulsion application rate in the wheel paths.

b. Nozzle Angle

Nozzles shall be positioned at an angle of 15 to 30 degrees from the horizontal of the spray bar in accordance with the spray bar manufacturers recommendation. All nozzles shall spray a full fan except for the right and left edge nozzles. The right and left edge nozzle shall be adjusted to a half fan such that the spray stays to the inside of the spray bar.

Commentary: The next step in calibrating the distributor is adjustment of the spray bar nozzle angles. Each nozzle has a slot cut across the face of the nozzle. When the nozzle is threaded into the spray bar, the slot should all be positioned at an angle of 15 to 30 degrees to the direction of the spray bar as shown in Figure 1. This angle provides the best position for achieving uniformity in the spray and the triple overlap coverage. The angle should be adjusted using the wrench supplied with the distributor. This wrench is designed when used properly to set the correct angles for each nozzle. Any wrench that fits the hexagonal nozzle can adjust the nozzle angle but correctness of the angle would have to be visually verified.

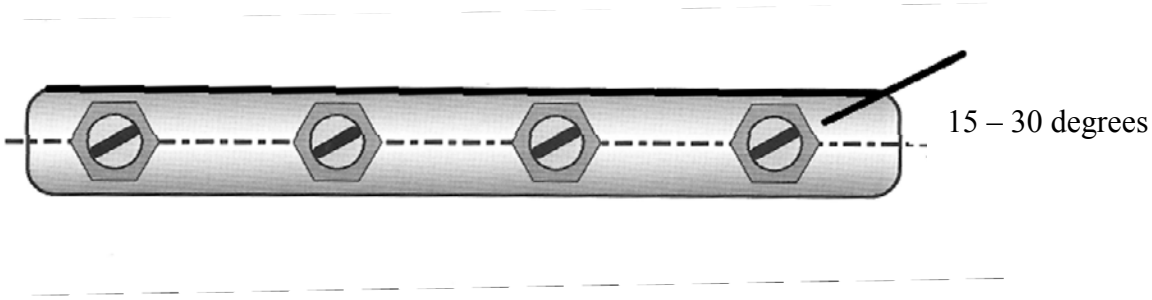

Figure 1- Spray Bar Nozzle Orientation in Spray Bar

The angle at which the nozzles are positioned shall be adjusted using the wrench supplied with the distributor.

However, in cases where this wrench is unavailable, a wrench that fits the hexagonal nozzle will suffice but the angle must be judged visually.
All nozzles fitted to the spray bar shall be full fan nozzles except for the right and left edge nozzles. These nozzles shall be half fan nozzles adjusted so the spray from the nozzle remains to the inside of the spray bar.

e. Spray Bar Height

The spray bar height must be adjusted so that the emulsion provides exactly two or three overlaps across the entire spray width.

Commentary
Streaking of the emulsion will occur if the spray bar is set too high or too low as shown in Figures 2 and 3.

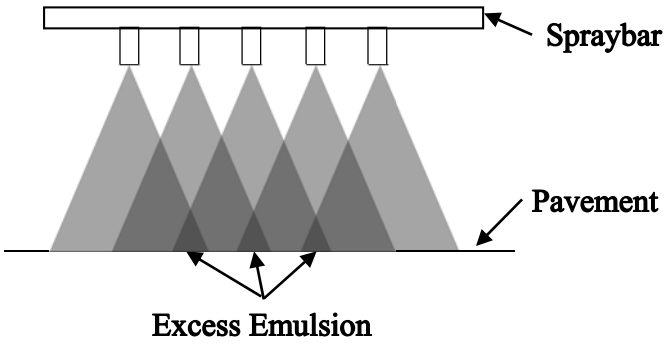

Figure 2- Streaks with Spray Bar Too High for Double Overlap

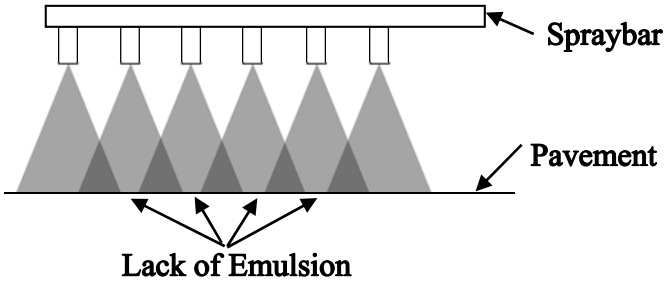

Figure 3 - Streaks With Spray Bar Too Low for Double Overlap

To avoid this streaking the bar must be adjusted to the correct height. This adjustment process is accomplished by shutting off nozzles to determine where the spray pattern contacts the pavement as shown in Figures 4 and 5.

Bar Height Adjustment to Achieve Double Lap

Every second nozzle shall be turned off when a double lap application is desired as shown in Figure 4. The distributor operator shall spray emulsion onto the pavement surface for as short an interval as possible while an observer watches where the emulsion hits the pavement from each nozzle left open. If there is overlap of emulsion from adjacent nozzles, the bar is too low. If there is a lack of emulsion from adjacent nozzles, the bar is too high.

Once it is confirmed the bar height is correct, the nozzles that were turned off can be turned back on and a double application of emulsion will result when spraying resumes.

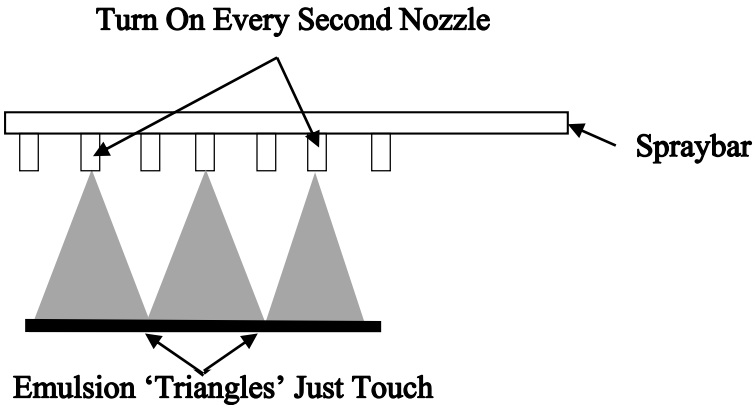

Figure 4 - Adjustment of Spray Bar Height for Double Overlap

Triple Lap Application Bar Height Adjustment

Every third nozzle shall be turned off when a triple lap application is desired as shown in Figure 5. The distributor operator shall spray emulsion onto the pavement surface for as short an interval as possible while an observer watches where the emulsion hits the pavement from each nozzle left open. If there is overlap of emulsion from adjacent nozzles, the bar is too low. If there is a lack of emulsion from adjacent nozzles, the bar is too high.

Once it is confirmed the bar height is correct, the nozzles that were turned off can be turned back on and a double application of emulsion will result when spraying resumes.

As the distributor empties during spraying, the bar height will rise. However, this is not usually enough to cause significant streaking worth adjustment of the spray bar.

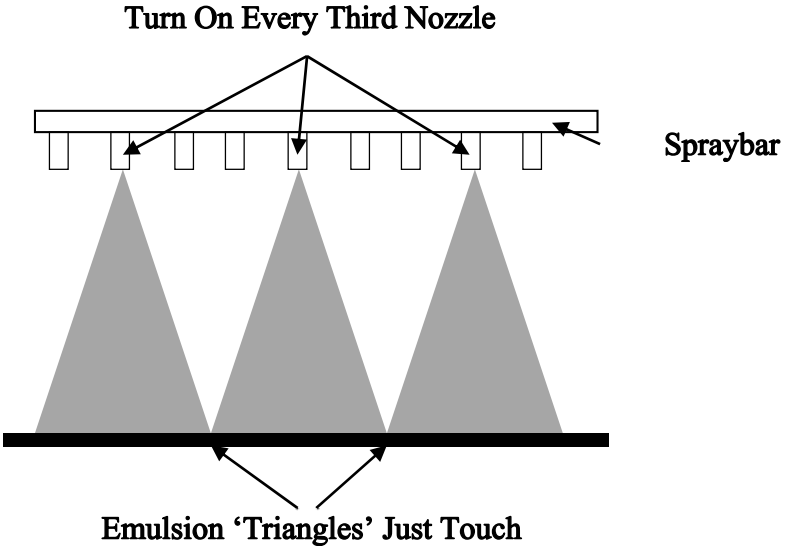

Figure 5 - Adjustment of Spray Bar Height for Triple Overlap

f. Transverse Flow Rate

The flow rate across the spray bar shall be uniform with each nozzle spraying within +/-10 percent of the average flow rate.

Commentary
This is done by measuring the width of the slot in the nozzle and by measuring the orifice diameter. Also, some nozzles are labeled by the manufacturer. Manufacturers supply a list of nozzles in the owner's document describing which nozzles shall be used for various application rates or on a placard mounted on the equipment.

However, nozzles of the same apparent size have been measured with different flow rates. Therefore, it is recommended that all nozzles be checked for flow rate before fog seal operations begin. This is easily accomplished by fabricating a flow apparatus. This apparatus consists of a pipe to which each nozzle can be fitted, in turn, on one end and a water source can be fitted to the other end. The flow of water through each nozzle shall be measured by filling a one gallon container in a measured period. This shall be done for each nozzle to be used on the project. If the flow rate of any of the nozzles is greater than 10 percent of the average of all the nozzles to be used these nozzles shall be discarded, or modified to flow within the 10 percent tolerance.

Determination of uniform lateral flow from the spray bar is determined by collecting a measured volume of emulsion in containers placed under each nozzle. This process is practical using standard 6-inch by 12-inch concrete cylinder

molds lined with one-gallon zip-lock freezer bags. The cylinder molds can be reused and the zip lock bags discarded appropriately with the contents.

g. Longitudinal Flow Rate

The longitudinal spray rate shall be accomplished by measuring the volume of emulsion in the distributor before and after spraying enough emulsion to reduce the volume of emulsion in the distributor by 70 to 90 percent.

Commentary
The longitudinal flow rate must be measured with all nozzles inserted in the distributor bar. First, the quantity of emulsified asphalt in the truck must be determined. Although there is a volume indicator on the rear of most modern distributors, these are not calibrated in small enough increments to be of use for longitudinal flow rate calibration and shall not be used for this purpose. Instead, the dip stick supplied with the distributor must be used. This dip stick is usually carried on the top of the tank near the inspection hatch. Prior to shooting emulsion, take a volume reading with the dip stick.

Pay attention to how the dipstick is used. Many dipsticks are not intended to be submerged in the emulsion, but instead, are inserted into the top of the tank only until the tip of the dipstick touches the surface of the emulsion. Then, the volume in the tank is read by indexing the top of the inspection cover to the reading on the dipstick.

Record this volume as 'beginning volume'. Set up the truck to shoot emulsion and shoot a minimum of 3000 feet by 12 feet of emulsion at the design rate using the gallon per minute pump flow volume and truck speed required by the manufacturer to attain this flow rate. Take a second dip stick reading. Record this reading as 'ending volume'. Subtract 'ending volume' from 'beginning volume' and record this as 'volume used'. Determine the area of emulsion sprayed. Divide 'volume used' by the area sprayed in square yards. This is the gallons per square yard applied to the pavement. This value shall then be compared to the distributor computer, if equipped, to evaluate the accuracy of the computer. A correction factor may then be applied to the computer output, if needed, and used for the remainder of the day. This calibration shall be accomplished each day.

An example of this calibration is presented below:

Given:
1800-gallon capacity asphalt distributor
12-foot-wide spray width
Trial spray distance = 3630 feet
0.32 gallon/yd^2 design spray rate
Dipstick reading beginning of shot = 1765 gallons

Dipstick reading end of shot = 265 gallons

Calculations:

7. *Check to see if enough volume shot. 1765-265=1500 gallons*
8. *1500/1765 = 85 percent >70% and <90%. OK, enough applied to be valid*
9. *Calculate spray rate = 1500 gallons / (12 x 3630/3) = 0.31 gallons/yd^2*

Therefore, decrease distributor speed, or recalibrate computer and re-check.

5. Blotter Sand Spreader

c. Transverse Spread Rate

<u>Commentary</u>
Various methods of calibrating this equipment have been used and the ASTM D5624 procedure can be effective. However, a visual assessment of the lateral distribution of sand is a good place to start the process since non-uniform distribution can easily be seen. The veil of sand deposited on the pavement from the spreader box can be viewed from behind with the spreader moving away from the observer or from the front. Either position for the observer is adequate for viewing how uniform the veil of sand is falling out of the spreader box. However, viewing from either front quarter affords the observer a better view of the entire spreader width and is, of course, safer than directly in front of the spreader. Any variation in light passing through the veil of sand indicates variation in application rate. More light means a lack of sand. Variation in light means the machine shall be stopped, the gates on the spreader contributing to the non-uniformity adjusted and the trial rerun. This procedure provides adjustment to the transverse spread rate. Then, to obtain an objective means of measuring the amount of sand being deposited, ASTM D5624, "Determining the Transverse Aggregate Spread Rate for Surface Treatment Applications" is a good procedure to use.

d. Longitudinal Spread Rate

Once the transverse spread rate is adjusted the longitudinal rate can be adjusted. This is also done visually, at first. This shall be done well before the emulsion begins to 'break' or 'set', but not immediately after spraying unless temperature, wind, or high demulsibility demand it.

The application rate of the sand shall be similar to the design rate. This is a rate where immediately upon dropping the sand, the appearance of the surface has some emulsion showing between the sand. In fact, the chip quantity should seem somewhat inadequate. The chip spread rate should not be low enough to cause pickup problems on rubber-tire rollers. However, the rate should be such that a small decrease in rate would cause pickup. Emulsion should be visible between

the sand upon dropping the sand and before rolling. It is the responsibility of the construction superintendent to achieve this application rate.

Evaluating the quantity of sand being placed is important after the rate is established. This provides a quantitative baseline for future work. The best method to accomplish this evaluation is by weighing the sand spreader before and after applying the sand and calculating the spread rate based on the area covered. This is often not practical. Therefore, a suitable alternative includes estimating the quantity of sand spread over a known area by knowing the weight of each transport truck supplying the spreader and dividing the estimated weight of sand spread by the area covered for that load.
An example follows:

Given:
Trucks loading the chip spreader are 12-ton capacity tandem dumps
12-foot-wide pavement
28 pounds per square yard design spread rate

Calculations:

11. Check Truck No. 1
a. Load = 23,803 lbs.
b. Spreader distance = 213 feet
c. Rate = 23,803/213x12/3 = 27.9 lbs./yd^2
12. Check Truck No. 2
a. Load = 23,921 lbs.
b. Spreader distance = 211 feet
c. Rate = 23,921/211 x 12/3 = 28.3 lbs./yd^2
13. Check Truck No. 3
a. Load = 23,848 lbs.
b. Spreader distance = 213 feet
c. Rate = 23,848/213 x 12/3 = 28.0 lbs./yd^2
14. Average Rate = (27.9 + 28.3 + 28.0) / 3 = 28.1 lbs./yd^2
15. No adjustment needed since measured rate is within 1 percent of design.

Compensation for moisture on sand must be considered when calibrating spreaders. The above example indicates no adjustment is needed since the measured spread rate is within 0.10 lbs/yd^2 of the design spread rate. However, if the sand above had contained as much as 1.02 percent moisture that was unaccounted for, the application rate would have been too low.

G. Test Strip:

Construct a 100-ft test strip and adjust the application rate as needed to assure a uniform application of the fog seal emulsified asphalt is applied with no streaking. Apply the fog

seal to minimize the amount of overspray and do not allow traffic on the fog seal until it has cured. The application rate shall not result in an excess of asphalt emulsion that could run off the pavement area to be sealed.

Commentary

Care should be taken to ensure the fog seal application rate does not cause a significant reduction in the surface texture of the pavement.

H. Application of Emulsified Asphalt

Apply the asphalt emulsion at the rate determined by the test strip or the ring test within +/-5 %. After applying the emulsified asphalt, place the cover aggregate at an application rate that just covers the emulsified asphalt or is sufficient to blot excess emulsion.

The temperature of the emulsified asphalt at the time of application shall be above 120F.

Commentary

If the temperature is lower than 120F there is risk of less material being applied than desired due to high viscosity.

The longitudinal construction joint for a fog seal must coincide with the painted lane line or at the outside edge of shoulder. There shall be no overlap of the longitudinal construction joint.

Allow the fog seal to cure undisturbed for at least 2 hours or until the emulsified asphalt breaks and is substantially tack free.

Cover unabsorbed asphalt with blotter aggregate to protect traffic or minimize rain damage.

Remove excess blotter aggregate after the asphalt is absorbed by sweeping.

I. Application of Cover/Blotter Aggregate

Cover or blotter aggregate shall be used for two purposes: 1) to blot excess asphalt emulsion prior to opening to traffic, and 2) to provide friction. After the emulsified asphalt has been sprayed and has begun to set, apply the aggregates. Aggregates shall be applied by the aggregate spreader if uniform application transverse and longitudinal to the pavement is required. Aggregates may be applied by hand when localized areas requiring blotting of excess emulsion are present.

J. Transverse Paper Joints

When beginning a new application of the fog seal transversely abutting the previously placed fog seal a transverse paper joint shall be used so excess asphalt and aggregates are not placed at the joint. The transverse paper joint shall be formed by placing 36-inch-wide Kraft paper on top of the previously applied fog seal so the edge of the paper aligns with the joint that will be formed when the previously placed fog seal meets the newly applied fog seal. The asphalt distributor shall begin applying asphalt emulsion by starting the application on top of the Kraft paper. After the distributor moves forward and over the joint the paper shall be removed.

Commentary

Ideally, the paper should also be placed at the end of the distributor shot, as well. This creates a clean, edge with the correct emulsion and fog quantity at the joint. Where the paper should be placed is calculated based on the emulsion shot rate and the quantity of emulsion in the distributor. The distance the distributor travels before encountering the paper and turning off the bar should be approximately equivalent to 80 percent of the distributor tank volume. This assures the distributor does not spray until empty which can result in less emulsion applied than desired at the end of the shot.

K. Traffic Control

Traffic may be allowed onto the fresh fog seal after the emulsion has completely set and after aggregates have been applied, if used.

L. Protection of Motor Vehicles

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

M. Sequence of Work

Construct the fog seal so that adjacent lanes are sealed on the same day when possible. If the adjacent lane(s) has not been sealed sweep all loose aggregates from the unsealed lane(s) before traffic is allowed on the surface without traffic control.

The permanent pavement markings shall not be placed for three days after placing the fog seal for water borne pavement marking or ten days for other types.

If fog sealing a new chip seal, the fog seal can be applied after the chip seal coat is cured, typically 1-2 days after construction.

Permanent pavement markings shall not be placed for three days after placing the fog seal.

Commentary

The fog seal will usually cure, or set, within 2 hours under dry conditions and temperatures above 60F. Interim pavement markings can be placed after the fog seal cures.

N. Quality Control

1. General

The Contractor is responsible for quality control (QC) sampling and testing and shall submit a QC plan including materials and procedures for verifying the quality of the fog seal aggregates and emulsified asphalt(s). The Contractor's QC plan shall include but is not limited to sampling, testing, inspection, monitoring, documentation, and corrective action procedures during transport, stockpiling and placement operations.

A written Quality Control Plan (QCP) shall be developed which details the Contractors's QC program that meets the requirements of these specificaitions. The QCP shall be contract specific and signed by the Contractors's representative. Fog seal construction shall not proceed without Agency approval of the QCP and QC personnel present on the project. Failure to comply with these provisions will result in shutdown of the operationsuntil such time as the Contractor's operations are in compliance.

2. Personnel

The QC staff shall include the following as a minimum:

a. QCP Administrator – The person with overall responsibility of the QCP

b. QCP Manager – The person responsible for the execution of the QCP and liaison with the Agency. This person shall be on the project, and have the authority to stop or suspend construction operations.
c. QC Technicians – The person(s) responsible for conductingQC tests and inspection to implement the QCP. QC technicians shall have Level 2 Aggregate Testing Certification from the American Concrete Institute (ACI) or other accrediting body approved by the Agency.
d. Certified Crew Members – Three crew members (job foreman, aggregate spreader operator and asphalt distributor operator), at a minimum, shall possess a valid fog seal certification and be on the project at all times the fog seal is being constructed. The fog seal certification is administered by the National Center for Pavement Preservation (NCPP) on behalf of AASHTO TSP^2 (Transportation Services Preservation Program).

3. Testing Facilities and Equipment

The Contractor shall provide the name of the laboratory conducting QC tests. The laboratory shall maintain accreditation by the AASHTO Accreditation Program (AAP) for all tests within the relavent scope of testing, or other accrediting body approved by the agency. Sampling, testing and measuring devices shall meet the requirements of the specified standards and test methods. The laboratory shall maintain records of the calibration and maintenance of all sampling, testing and measuring equipment.

4. Materials Testing

Fog seal aggregates and asphalt emulsion shall be tested for compliance with the specifications as follows:

Aggregate

a. Stockpile.
Test the aggregate gradation a minimum of once per day, or every 1500 tons, whichever is greater in accordance with AASHTO T27 to determine compliance with Table 1 requirements. If the material is hauled from the production site to a temporary stockpile, test at the temporary stockpile.

b. Construction.
Test the aggregate gradation from the hopper of the fog spreader a minimum of once per day, or every 1500 tons, whichever is greater in accordance with AASHTO T27 to determine compliance with Table 1 requirements. The testing rate for quality values in Table 5 shall be once per source.

Emulsified Asphalt

Only emulsified asphalt from certified or approved sources is allowed for use. Verify the emulsion(s) meet the specifications by obtaining certificates of compliance from the supplier.

Verify the application rate of the emulsified asphalt by dividing the volume of emulsified asphalt used by the area fog sealed each day. Allowable variation is +/- 5% of the application rate adjusted from the design quantity. Provide material certification and quality control test results for each batch of emulsified asphalt used on the project. Include the supplier name, plant location, emulsion grade, and batch number on all reports.

5. Calibration of Equipment and Workmanship

Describe the equipment and methods used for equipment calibration and workmanship as follows:

a. Longitudinal application rates
b. Transverse application rates
c. Asphalt transverse application uniformity
d. Transverse joint construction technique
e. Monitoring method for application rates
f. Sweeping operations and schedule, if aggregate is applied
g. Method of controlling traffic

6. Documentation

Describe the documentation and reporting procedures for all QC activities. Include samples of all QC test forms, inspection and test reports.

7. Records and Documentation

The Contractor shall maintain complete records of all QC tests and inspections. All QC test results shall be submitted to the Agency at the end of the contract. A material certification shall be submitted from each supplier for each batch of material delivered to the project, including test results.

The QC records shall contain all test and inspection reports, forms and checklists, equipment calibrations, supplier material certificates, and non-conformance and corrective action reports. The QC records shall indicate the nature and number of observations made, the number and type of deficiencies found, the quantities conforming and non-conforming, and the nature of corrective action taken as appropriate for materials as well as workmanship. The QC records shall be available to the Agency at all times, and shall be retained by the contractor for the life of the contract. The Contractor's documentation procedures will be subject to approval by the Agency prior to the start of work, and to compliance checks by the Agency during the progress of the work.

8. Compliance with Specifications

   The Contractor shall attest in writing to the Agency that the fog seal has been constructed in accordance with and meets the requirements of the specifications at the conclusion of the project.

O. Agency Acceptance

1. General
   The Agency will conduct acceptance sampling, testing, and inspection activities to ensure material quality, correct application rates, sweeping, and traffic control are within specification requirements. These activities will be done randomly by the Agency.
2. Acceptance Activities
   i. Materials Testing

      Aggregate (if used)

      Sample aggregate taken from the aggregate spreader hopper once per day. Samples will be stored and tested for gradation at the discretion of the Agency. If the results vary from the requirements of Table 1, a price reduction will be applied per the Schedule of Price Reduction prepared by the owner agency.

      Emulsified asphalt

      Sample the first shipment and provide one sample for every 50,000 gallons (approximately 200 tons) thereafter. Testing of emulsions shall be in accordance with AASHTO M140, M208, and M316.
3. Equipment

   All equipment to be used on the project shall be evaluated by the Agency to assure it is in acceptable operating condition, calibrated correctly and will provide the quantities of material specified.
4. Final Inspection

   A final inspection will be done to assure that no bleeding or flushing, excessive fog loss or crushed aggregate has occurred. Longitudinal and transverse joints will be inspected to assure that no excessive overlap has occurred.

410.04 MEASUREMENT

The Engineer will measure the acceptably completed fog seal as specified in Subsection 109.01 of the AASHTO Construction Guide Specifications or as follows:

A. Emulsified asphalt

Measure the undiluted emulsified asphalt by volume, at 60F.

B. Aggregate

Aggregate will be paid for by the area of pavement surfaced.

410.05 PAYMENT

Payment for fog seals can be done by either paying for the materials as unit costs, or for the completed fog seal by area of pavement sealed.

Commentary

The advantage of payment by the square yard for a completed fog seal is simplicity if the area is easily defined. The disadvantage is that an incentive is created to reduce material quantities. Reduced asphalt emulsion quantities can lead to chip loss and vehicle damage.

A. Payment by Unit Price

The Agency will pay for accepted quantities at the contract price as follows:

1. Payment for the accepted quantity of emulsified asphalt and aggregate for fog seal (including any required additives) at the contract bid price of measure is compensation in full for all costs of furnishing and applying the material as specified.

2. Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure.

Item No.	***Item***	***Unit***
State ##	Emulsified asphalt for fog seal……	Gallon
State ##	Aggregate for fog seal……..	Tons
State ##	Diluted emulsion for fog seal, if used.....	Gallon

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

B. Payment for Completed Fog Seal

1. Payment for the accepted quantity of the fog seal at the Contract bid unit price of measure is compensation in full for all costs of furnishing and applying the material as specified, including cleaning the existing pavement, stationing, purchase of

aggregate, delivery of aggregate, all labor, equipment, and materials necessary for the placement of the chip seal for full lane coverage, sweeping of any loose aggregate after construction and other requirements as specified.

2. Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure.

Item No.	***Item***	***Unit***
State ##	Fog seal…….	Square Yard
State ##	Diluted emulsion for fog seal, if used.....	Gallon

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

Commentary

The advantage of payment by the square yard for a completed fog seal is simplicity if the area is easily defined. The disadvantage is that an incentive is created to reduce material quantities.