CHAPTER 6 FOG AND REJUVENATING SEALS

6.1 OVERVIEW

All asphalts harden as they age, primarily due to oxidation, loss of lighter oils (maltenes). Hardening of asphalt takes place at different rates depending on environmental conditions and the exposure to air. Permeable pavements or pavements with high void contents can therefore age faster. Water ingress can also carry dissolved oxygen and trace elements that may promote aging. This means that pavements with open surfaces tend to age faster than those with closed surfaces.

Aging results in a binder that is more brittle. These binders eventually experience cohesive binder failures under traffic loads and stone loss or raveling. In some cases, the asphalt produces oxidized compounds that are acidic and bond well to the aggregate; however, these compounds may also react with water causing adhesive failure or stripping.

Fog and rejuvenating seals are two of many pavement preservation strategies used to defer surface degradation and extend pavement surface life. The primary purpose of using a fog seal is to seal the road surface and defer surface degradation. The primary purpose of using rejuvenating seals is to soften the stiffness of the oxidized pavement surface and to extend the life of the pavement surface by adjusting properties of the hot mix asphalt (HMA) mixture. Some rejuvenators contain asphalt which also seals the surface in addition to adjusting the properties of the HMA mixture.

There is, at the present time, no simple way of quantifying the degree of aging in a pavement other than by visual inspection. Pavement will age at different rates due to mixture's properties, traffic applications, and environment effect. Some modified asphalts such as asphalt rubber and polymer modified asphalts will age at a slower rate than conventional binders. The experience of individual districts is key to determination of treatment timing.

6.1.1 Fog Seal

Fog seals are a mixture of asphalt emulsion and water applied to the asphalt surface of a road, street or highway. The Asphalt Emulsion Manufacturers Association (AEMA) defines a fog seal as "a light spray application of dilute asphalt emulsion used primarily to seal an existing asphalt surface to reduce raveling and enrich dry and weathered surfaces". Fog seals are also useful in chip seal applications to hold chips in place in seal coats. These are referred to as flush coats in California. They can help prevent vehicle damage arising from flying chips. Fog seals can seal hairline cracks.

Fog seals are a method of adding asphalt to an existing pavement surface to improve sealing or waterproofing, prevent further stone loss by holding aggregate in place, or simply improve the surface appearance.

6.1.2 Rejuvenating Seal

Rejuvenating seals are a combination of various rejuvenating oils or a mixture of asphalt emulsion and recycling oils applied to the asphalt pavement surface. There are a variety of rejuvenating seals used in California. Rejuvenating emulsions restore the maltenes or light components that have oxidized and soften the existing binder, thus reducing the viscosity and improving the flexibility of the binder. This is beneficial in situations where the surface has an open texture and the existing binder is brittle from age. For the seals to be effective they must penetrate into the existing asphalt concrete surface. Rejuvenators can seal hairline cracks by expansion of the binder.

6.2 PROJECT SELECTION

6.2.1 FOG SEAL

General Considerations

Fog seals are used as a method of sealing a pavement surface and as a method of holding stone in place. They are suitable to treat raveled, aged or oxidized pavements. Fog seals will not correct distresses such as cracking, base failures, excessive stone already lost, or any other severe pavement defects.

On the traveled way, fog seals should only be used where there is adequate surface texture such as aged and raveled hot mix surfaces, chip-sealed surfaces, and open graded asphalt surfaces. On shoulders, gores, or dikes surface texture is not as critical. Fog seals will darken the surface creating good contrast.

For projects requiring that the sealed pavement be opened to traffic shortly after the application of the seal, fast break emulsions can be considered. Regardless, adequate break or cure time should be allowed. A blotter coat of sand may be used to prevent pick-up. The sand will generally be removed by the traffic leaving a good surface texture.

Fog seals with light sanding are used as a construction seal for new chip seals to lock the chips in place. This reduces vehicle/windshield damage due to flying chips when traffic is allowed on the new seal. Additionally fog seals with light sanding are can be used on older pavements to seal and restore some surface texture.

During construction on milled or ground HMA surfaces, fog seals may be used to keep dust down and prevent rock loss before the next surface is placed.

Fog seals may be used to protect newer hot-mix asphalt surfaces that have not aged significantly provided there is adequate surface texture. This creates a layer of asphalt that seals surface voids and prevents air and water intrusion.

Benefits and Limitations

Fog seals are an inexpensive way of arresting raveling and adding binder back into aged surfaces. They can also hold chips in place in fresh chip seals or older chip seals beginning to loose rock, reducing the potential for vehicle damage.

Fog seals are not useful as seal coats on tight surfaces without the addition of aggregates as they will reduce surface texture.

The application of fog seals can be limited by weather. Seal coats should not be applied in cool wet weather because they may not cure and could be prone to cause slick surface conditions.

Summary

In summary, the following guidelines should be considered when selecting a fog seal project:

- Pavement surface condition – Dry mixes, high air voids, surfaces showing minor and/or moderate raveling, good profile with minimal or no base failure. Pavement age - any age
- Pavement surface mix – can be used on chip seals, dense, gap and open-graded mixes and all pavement surfaces with adequate surface texture.

6.2.2 Rejuvenating Seal

General Considerations

Rejuvenator Seals are used as a method of sealing the pavement surface and rejuvenating the existing asphalt binder in the top surface. They are suitable for use on pavements with open texture, dry or brittle condition. The can be used on any age pavement though should only be used where there is adequate surface texture that allows for absorption in the pavement. On shoulders, gores, or dikes surface texture is not as critical.

Polymer modified rejuvenating emulsions (PMRE) without dilution can be used in scrub and chip seal applications on all types of pavement. Their particular binder qualities make them very well suited to chip and scrub seal applications. Clean cover aggregate is generally not necessary when using PMRE binders.

For projects requiring that the sealed pavement be opened to traffic shortly after the application of the rejuvenator, fast break rejuvenating emulsions can be considered. Regardless, adequate break or cure time should be allowed. A blotter coat of sand may be used to prevent pick-up.

Benefits and Limitations

Rejuvenating emulsions reduce the viscosity and soften the hardness of oxidized asphalt, making it less brittle. The major benefit of the rejuvenating seal is to improve the flexibility of the asphalt binder and slow down the rate of aging and oxidization.

PMRE seals are useful as seal coats on tight surfaces because the addition of aggregates will increase surface texture.

The application of rejuvenator seals can be limited by weather. They should not be applied in cool wet weather because they will not break and cure and could be prone to cause slick surface conditions.

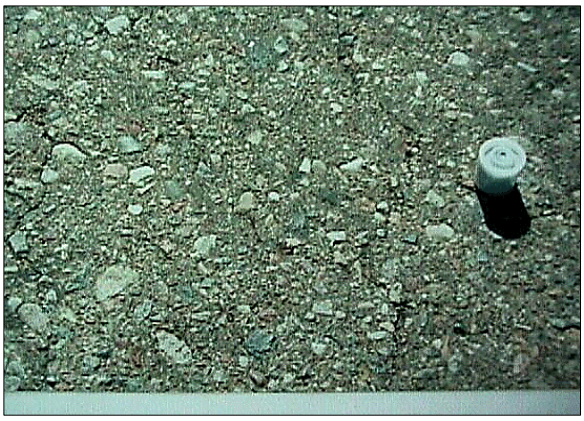
Summary

In summary, the following guidelines should be considered when selecting a rejuvenating seal project:

- Pavement surface condition – exhibiting dryness, raveling, oxidation, minor cracking or surface distress with minimum or no base failure. In addition, a pavement surface may begin to show evidence of distress cracking; if this is the case a rejuvenating scrub or chip seal may be used.
- Pavement surface mix – can be used on chip seals, dense, gap and open-graded mixes and all pavement surfaces with adequate surface texture that allow penetration and absorption. PMRE scrub and chip seals may be used on any pavement.
- Pavement age – any pavement

6.2.3 Pavement Surfaces and Applications

Figure 6-1shows various surfaces suitable for both fog seal and rejuvenator seal applications as well what some of these surfaces should look like within an hour of application.



Dry, aged DGAC with open surface texture suitable for fog or rejuvenator seal with application rates typically ranging from 0.08-0.10 gal/sq yd at 50/50 dilution

New tight DGAC surface. Application rates of more than 0.06 gal/sq yd could result in slick surface. Not suitable for fog or rejuvenator seal on high speed facilities.

Good application of polymer modified rejuvenating emulsion at 0.10 gal/sq yd on gap graded rubber.

Good application of fog seal to new chip seal.

5 year old DGAC surface. Aggregate is exposed but surface is tight .Emulsion will not penetrate. Not suitable for fog seal or rejuvenator seal.

3 year old 3/8" OGAC. Suitable surface for fog seal and rejuvenator seal with application rates as high 0.12 gal/sq yd.

Figure 6-1

6.3 MATERIALS

6.3.1 General Terminology

Essential emulsion terminologies used for fog and rejuvenating seals are defined below:

- **Original emulsion** – A mixture of asphalt or base oil and water that contains a small amount of emulsifying agent. Original slow-setting grade emulsions contain up to 43 percent water and original rapid setting grade
- **Diluted emulsion** – Is am emulsion concentrate that is further diluted with water up to 1:1 emulsion to water.
- **Residual asphalt content** – The amount of asphalt remaining on the pavement surface after the emulsion has broken and cured (after all water has evaporated).

6.3.2 Materials and Specifications

Fog Seal treatments will be covered in NSSP 37-050. This specification is under development.

The emulsion types recommended for fog seals may be cationic (i.e., a positive surface charge on the asphalt particles), or anionic (i.e., a negative surface charge on the asphalt particles). The primary types used are:
CSS-1h – Cationic Slow Set
SS-1h - Anionic Slow Set
CQS-1h – Cationic Quick Set
LMCQS-1h – Latex Modified Cationic Quick Set

Rejuvenator seal treatments will be covered in NSSP 37-600. This specification is under development.

6.3.3 Design Considerations

Fog seals and rejuvenating seals are designed based on the existing pavement surface condition. The design objective is to determine the application rate and sometimes dilution rate. The actual application rates may vary during the construction.

6.3.4 Estimating Application Rates

To estimate the application rate a ring test or other suitable measurement can be performed. Essentially a known quantity of emulsion is applied uniformly over a known area. If the emulsion is not absorbed into the surface after 15-20 minutes, decrease the application rate of the emulsion and apply to a new area until the approximate application rate is found. Because surface conditions vary, several tests should be made on each project to determine the appropriate application rate. Wheel tracks should always be tested because of the potential for less or more absorption in these areas. Figure 6-2 shows two of methods for determining application rate.

Ring test kit. The small plastic vial is scribed with marks equivalent to 0.10 and 0.20 gal/sq yd when applied to the 6" dia circle. Other application rates are estimated.

Determining application rate using sprayer and scale. Sprayer is weighed, material is sprayed over 1 sq yd, and sprayer weighed again.

Figure 6-2

6.4 CONSTRUCTION

The majority of this section is focused on the construction of fog seals, however, some parts, such as surface preparation and traffic control would also be applicable to rejuvenating seal jobs. Construction of rejuvenating seals should follow the manufacture's guidelines and recommendations to achieve desired end products.

6.4.1 General Description

A fog seal or rejuvenator seal is designed to coat, protect, and/or rejuvenate the existing asphalt binder. The addition of asphalt will improve the waterproofing of the surface and reduce its aging susceptibility by lowering permeability to water and air. To achieve this, the fog seal emulsion must fill the voids in the surface of the pavement. Therefore, during its application it must have sufficiently low viscosity so as to not break before it penetrates the surface voids of the pavement. Emulsions that are not adequately diluted with water may not properly penetrate the surface voids resulting in excess asphalt on the surface of the pavement after the emulsion breaks, which can result in a slippery surface. Rejuvenation emulsions that do not contain asphalt are designed to penetrate the surface of the pavement co-mingling and fluxing with the asphalt binder.

During application, the emulsion wets the surface of the aggregate and the existing binder film. Cationic (positively charged) emulsions can displace water from the surface of an aggregate or aged asphalt film. The emulsion then breaks by loss of water and chemical action, forming a film of new binder on the aggregate and existing binder film. The rate at which the emulsion breaks is dependent on several factors with weather conditions (e.g., wind, rain, temperature, etc.) being dominant factors. For anionic (negatively charged) emulsions, there is no surface specific interaction with most aggregates. The emulsion breaks due to water loss by evaporation and absorption of water by the aggregates and surface voids of the pavement.

6.4.2 Site Conditions

To be effective, fog seals need to break and cure completely. Thus, warm conditions with little to no chance of rain are necessary to ensure successful applications. Fog seals should be applied when the ambient temperature is 50°F (10°C) and rising. High temperatures will speed the break however they may also cause the material to remain tacky. A relatively cool night following application will help the material to set.

6.4.3 Surface Preparation

Immediately before applying a fog seal, the pavement surface must be clean and dry. If flushing is required, it should be completed 24 hours prior to the application of the fog seal to allow for adequate drying.

6.4.4 Materials Preparation

Asphalt emulsions (original emulsions) contain up to 43% water, but must be diluted further before use. This additional dilution reduces viscosity (see Figure 6-3) and allows the application of small amounts of residual binder to be adequately controlled. Generally, the supplier will dilute the original emulsion, in the field or at the plant. A dilution rate of 50% (1:1) (equal parts water to equal parts emulsion) is recommended in NSSP 37-600 and SSP 37-050.

This is the "normal" rate of dilution, but not always the best. During cooler conditions, on steep grades, tight asphalt surfaces, etc., it will be difficult to hold a 0.10 gallon/ square yard application of diluted seal coat on the surface. In order to get the (normally desired optimum) 0.03 - .035 gal/ square yard residual asphalt on these conditions, it sometimes takes a .08 gal/square yard application of 60/40 or .07 gal/square yard @ 70/30 ratio. Using these guidelines, a less experienced user will just cut the application rate without changing the dilution rate, sacrificing the performance of the seal by reducing the residual asphalt. The dilution rate should be set by the Engineer. Dilution water must be potable and free from detectable solids or incompatible soluble salts (hard water).

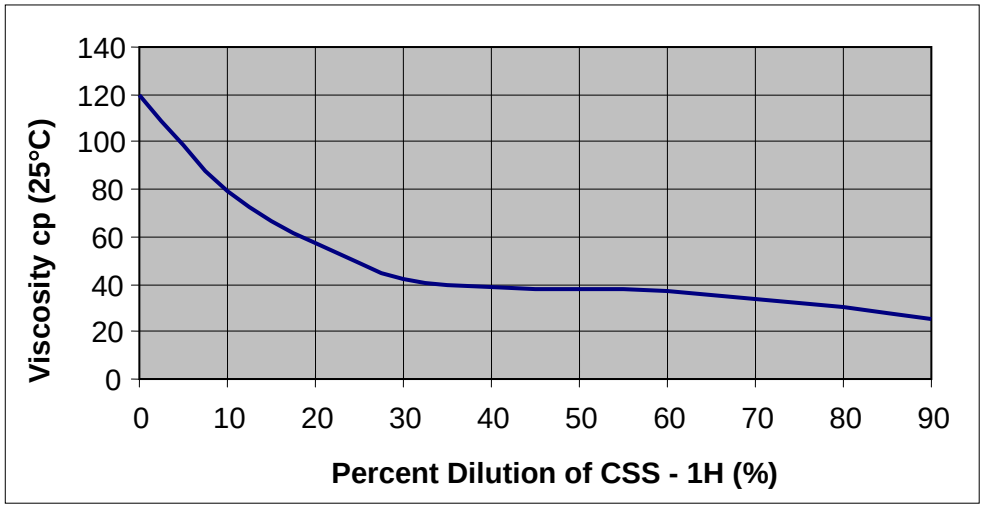


Figure 6-3 Viscosity Change with Dilution

NOTE:

Water can be checked for compatibility with the emulsion by mixing a small amount of the emulsion in a can (approximately 0.26 gal [1 liter]). The materials are mixed for 2 to 3 minutes with a stirrer and the resulting mixture is poured through a pre-wetted No. 100 (150 μm) sieve. If more than 1% by weight of material is retained on the sieve, the water is not compatible and clogging in spray jets may result. This test is illustrated in Figure 6-4.

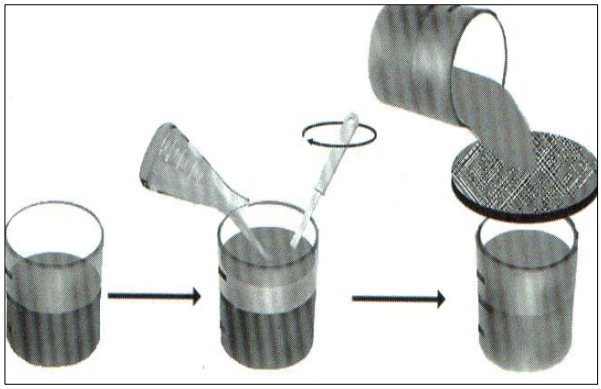


Figure 6-4 Simple Water Compatibility Test Method

Incompatible water may be treated with 0.5 to 1.0% of a compatible emulsifier solution (the emulsion manufacturer can provide advice regarding compatible solutions). The emulsifier solution should be added to the water tanker and circulated for 10 to 15 minutes via pump before adding to the emulsion. If a water treatment is used, the compatibility test should be repeated using the treated water to ensure compatibility.

The emulsion should be diluted no more than 24 hours before its intended use. This is to avoid settlement of the diluted emulsion. Water is always added to the emulsion and not the other way around. The emulsion may be circulated using a centrifugal or other suitable pump to ensure uniformity.

6.4.5 Application Rates

Properly calibrated distributor trucks shall be used to apply the emulsion. Spray nozzles with 1/8" to 3/16" openings are recommended. The emulsion may be heated up to 122 °F (50°C) maximum, although, generally the emulsion is sprayed at ambient temperature. The emulsion is sprayed at a rate that is dependant on the surface conditions (see section 6.3.4). Typical application rates for diluted emulsion (1:1) range from 0.06 to 0.12 gal/yd^2 depending on the surface conditions. A 1:1 diluted emulsion is an original emulsion that has been subsequently diluted with equal parts water. Table 6-1 outlines the recommended application rates for varying surface types and degree of dilution. A short field check of the recommended application rate should always be conducted to confirm or adjust the application rate up or down.

Table 6-1 Recommended Application Rates

% ORIGINAL EMULSION	DILUTION RATE	TIGHT SURFACE* (gal/yd^2)	OPEN SURFACE** (gal/yd^2)
100	0	0.01 – 0.03	0.03 – 0.05
50	1:1	0.06 – 0.11	0.09 – 0.22
40	1.5:1	0.04 – 0.12	0.11 – 0.29
25	3:1	0.055 – 0.20	0.18 – 0.044
20	4:1	0.06 – 0.25	0.22 – 0.57

6.4.6 Traffic Control

Besides worker safety, traffic Control is required to protect the integrity of the application and to prevent tracking.

6.4.7 Quality control

Quality control and workmanship are critical to the performance and life of a fog seal treatment. There must be a cooperative effort between the agency's representative and the contractor's representative to conduct inspections of all project equipment before and during the project. The primary pieces of equipment for a fog seal operation are the boot truck/equipment and distributor bar. It is critical that each is functioning as required by the project specifications. The spray bar must be set to the appropriate height (distance) from the pavement surface and the nozzles must be set at the proper angle to assure a uniform application of material. The material temperatures should also be measured for quality control purposes.

The emulsion must be certified to specification according to established sampling and testing procedures.

Figure 6-5 shows a fog seal application and the importance of spray bar height.

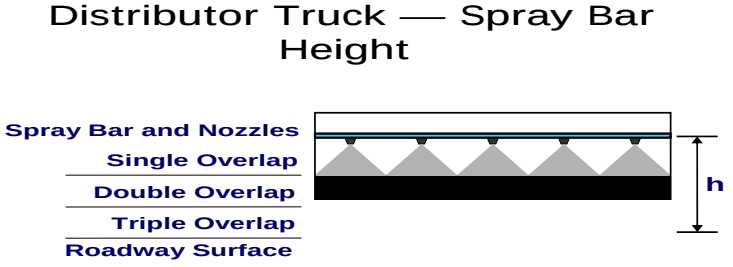


Figure 6-5

6.4.8 Post Treatment

Sand cover may be used at approximately 1-2 lbs. per square yard to allow for early opening to traffic. Sweeping may be required. The project supervisor should assess this after application and before opening to traffic. If the material remains tacky due to high temperatures a light application of water from a water truck will set the material and alleviate the potential for tracking.

6.5 TROUBLESHOOTING AND FIELD CONSIDERATIONS

6.5.1 Troubleshooting Guide

This section provides information to assist project personnel in troubleshooting problems with fog seals and rejuvenator seals along with "dos and don'ts" that address common problems that may be encountered during the course of a project.

The troubleshooting guide presented in Table 6-1 associates common problems to their potential causes. For example, a slick surface may be caused by wet pavement, a high application rate, or rain. Cold weather could also contribute to slick pavements as the emulsion break may be delayed. The emulsion will be tacky and pickup if the existing road surface is dusty, too hot, or the wrong emulsion is used.

In addition to the troubleshooting guide, Table 6-2 lists some application problems and their recommended solutions.

Table 6-1 Trouble Shooting Fog Seal Problems

CAUSE	PROBLEM						
	SLICK SURFACE	NOT BREAKING	WASHES OFF	TACKY PICKS UP	WILL NOT DILUTE	BREAKS TOO FAST	DILUTION WRONG
Road Wet	●	●	●				
Road Too Dry				●		●	
Road Dusty				●		●	
Hard Water					Anionic		
Alkaline Water					Cationic		
Acidic Water					Anionic		
Application Too High	●	●	●	●			●
Application Too Low						●	●
Wrong Emulsion		●	●	●	●	●	
Rain	●	●	●				
Cold Weather	●	●					
Hot Weather				●		●	

Table 6-2 Common Problems and Related Solutions

PROBLEM	SOLUTION
Spattering of the Emulsion	▪ Reduce the rate of dilution. ▪ Ensure the spray bar height is set correctly. ▪ Ensure the spray pressure is not set too high.
Streaking of the Emulsion	▪ Ensure the emulsion is not too cold. ▪ Ensure the emulsion viscosity is not too high. ▪ Ensure the nozzles are at the same angle. ▪ Ensure the spray bar is not too high or too low. ▪ Ensure the spray bar pressure is not too high. ▪ Ensure all nozzles are not plugged.
Bleeding or Flushing of the Emulsion	▪ Ensure the emulsion application rate is not too high. ▪ Check application and dilution rate and recalibrate sprayer, if necessary.

6.5.2 Dos and Don'ts

The following list provides a quick reference to avoid making common mistakes with fog seals.

Do check water compatibility before dilution.
Do check dilution - has it been done, by whom, and when?
Do ensure that there is no contamination of the base emulsion by water, oils, or other liquids.
Do prevent contamination by other emulsions.
Do protect emulsions from freezing or localized boiling due to the application of direct heat.
Do heat emulsion gently and ensure heating coils are under the liquid level (max 122°F (50°C)).
Do load from the bottom of tankers or sprayers to avoid foaming.
Do check equipment and nozzles.
Do check application rates.
Do exercise proper traffic control.
Do ensure the know-how is available on the job.
Do add water to emulsion, not emulsion to water.
Don't store diluted emulsion longer than 24 hours.
Don't continuously stir or circulate emulsion.
Don't apply emulsion if air temperature is < 50°F (10°C) and pavement temperature < 60°F (15°C).
Don't apply emulsion if rain or cool temperatures are imminent.
Don't continue application if adequate breaking period is not available.

6.5.3 Field Considerations

The following field considerations are a guide through the important aspects of performing a fog-sealing project. The various tables contain items that should be considered in order to promote a successful job outcome. Thorough answers to these questions should be determined, as required, before, during, and after application of fog seal. The appropriate staff to do this will vary by job type and size. Some topics may need attention from several staff members. The field personnel should be acquainted with its contents. The intent of the tables is not to form a report but to bring attention to important aspects and components of the project process. Some information is product specific and contained in the relevant standard specifications, standard special provisions, or special provisions.

PRELIMINARY RESPONSIBILITIES	
PROJECT REVIEW	▪ Is the project a good candidate for a fog seal? ▪ What is the existing surface type? ▪ Has an assessment been made of the surface absorption? ▪ How much stone has been lost? ▪ How much bleeding or flushing exists? ▪ Review project for bid/plan quantities. ▪ What is the relative cost?
DOCUMENT REVIEW	▪ Bid specifications. ▪ Special provisions. ▪ Emulsion Specifications. ▪ Traffic control plan (TCP). ▪ Material safety data sheets.
MATERIALS CHECKS	▪ Emulsion selection. Type and dilution rate. ▪ The emulsion is from an approved source (if required)? ▪ The emulsion has been sampled and submitted for testing (if required)? ▪ The water to be used is compatible with the emulsion? ▪ Is sand required? Is it within specification and dry? ▪ Is the emulsion temperature within application temperature specification?
PRE-SEAL INSPECTION RESPONSIBILITIES	
SURFACE PREPARATION	▪ Is the surface clean and dry? ▪ Have all pavement distresses been repaired? ▪ Has the existing surface been inspected for drainage problems?

EQUIPMENT INSPECTION RESPONSIBILITIES	
BROOM	▪ Are the bristles the proper length? ▪ Can the broom be adjusted vertically to avoid excess pressure on the surface?
SPRAY DISTRIBUTOR	▪ Is the spray bar at the proper height? ▪ Are all nozzles uniformly angled at 15 to 30 degrees from the spray bar axis? ▪ Are all nozzles free of clogs? ▪ Is the spray pattern uniform and does it properly overlap (double or triple)? ▪ Is the application pressure correct? ▪ Is the distributor properly calibrated? ▪ Is there a working and calibrated thermometer on site? ▪ Has water been added to emulsion in correct proportion and circulated? ▪ Is the application rate being monitored throughout the day/project?
SAND SPREADER	▪ Do the spreader gates function properly and are their settings correct? ▪ Is the sand spreader's calibration uniform across the entire head? ▪ Is the sand free flowing? ▪ Are the truck hook-up hitches in good condition?
TRUCKS	▪ Is the truck box clean and free of debris and other materials? ▪ Is the truck hook-up hitch in working order? ▪ Is a truck box apron or extension required for loading the sand spreader?
ALL EQUIPMENT	▪ Is all equipment free of leaks? ▪ Is all equipment calibrated and clean?
SITE CONSIDERATIONS	
TRAFFIC CONTROL	▪ Do the signs and devices used match the traffic control plan? ▪ Does the work zone comply with Caltrans traffic control policies as laid out in the Caltrans Safety Manual? ▪ Do flaggers not hold the traffic for extended periods of time? ▪ Does the pilot car lead traffic slowly — 25 mph (40 kph) or less—over fresh sand blotted fog seals? If not sanded, allow at least 2 hours before opening to traffic. ▪ Are unsafe conditions promptly reported to a supervisor (contractor or agency)? ▪ Are signs removed or covered when they no long apply?

SITE CONSIDERATIONS	
WEATHER REQUIREMENTS	▪ Are minimum surface and air temperatures adhered to? ▪ Are air and surface temperatures checked at the coolest location on the project? ▪ Do air and surface temperatures meet agency requirements? ▪ Are high winds expected during application of the fog seal? High winds can create problems with the diluted emulsion application. ▪ Will the expected weather conditions delay the breaking of the emulsion? High temperatures, humidity, and wind will effect how long the emulsion takes to break. ▪ Is the application of the fog seal discontinued if rain is likely?
BINDER CONSIDERATIONS	
BINDER APPLICATION	▪ Are the agency guidelines and requirements being followed? ▪ Has a check been done on the absorption ability of surface? ▪ Is the surface oxidized and porous? More oil can be applied to dried-out and porous surfaces. ▪ Is the surface smooth, non-porous, or bleeding (asphalt rich)? Do not apply to smooth, non-porous, and asphalt-rich surfaces. ▪ Is the traffic volume on the road high? Less oil must be applied on roads with high traffic volumes. ▪ Does the emulsion soak into the surface? If not, application rate is too high. ▪ Is the surface texture coarse? If so, spray should be applied in both directions to avoid build up on one side of stones. ▪ Are manhole covers and drainage inlets covered to keep binder from entering water bodies?
CHECKING APPLICATION RATES	**Binder - Method A (Recommended for Calibration)** ▪ The weight of a 1 yd^2 (0.84 m^2) carpet, pan or, non-woven geotextile material is recorded and placed on the road surface. ▪ The distributor applies emulsion over the carpet, pan, or geotextile material. ▪ The weight of the carpet and emulsion, pan and emulsion, or geotextile material and emulsion is recorded. ▪ The weight of the carpet, pan, or geotextile material without emulsion is subtracted from the weight of the carpet, pan, or geotextile material with emulsion. ▪ The weights applied to the area of carpet (i.e., lb/yd^2 or kg/m^2) must be converted to the units of the control mechanism, which is gal/yd^2 or l/m^2, through knowledge of the specific gravity of the emulsion. If the distributor is not spraying the binder at the correct application rate, adjustments must be made to the controls and the process described above repeated until the correct application rate is achieved. Although this is the responsibility of the contractor, the inspector should verify that the distributor is spraying the binder at the correct application rate.

BINDER CONSIDERATIONS

CHECKING APPLICATION RATES

Example – Checking Fog Seal Application Rate (Method A)

- Given:
  Applying a Fog Seal with a 1:1 diluted emulsion.
  Tight surface texture.
  Recommended application rate of 0.06 – 0.11 gal/yd^2 (see Table 7-1).
  Specific gravity of Emulsion (G_E) = 1.010.
  Unit Weight of Water (γ_W) = 62.4 lb/ft^3.
  Conversion Factor (C_{fl}) = 7.5 gal/ft^3.

Find the actual application rate ($W_{A'}$).

- Measure the weight of a 1 yd^2 carpet (W_C).
  (W_C) = 4.0 lb
- Measure the weight of 1 yd^2 carpet and applied emulsion (W_{C+E}).
  (W_{C+E}) = 4.7 lb
- Calculate the weight of emulsion covering the 1 yd^2 carpet (W_E).
  (W_E) = (W_{C+E} - W_C)
  (W_E) = (4.7 lb - 4.0 lb)
  (W_E) = 0.7 lb
- The application rate is the weight of emulsion applied per unit area (W_A).

$$(W_A) = \left(\frac{W_E}{1yd^2}\right)$$

$$(W_A) = \left(\frac{0.7lb}{1yd^2}\right)$$

$$(W_A) = 0.7\frac{lb}{yd^2}$$

Convert this application rate to gal/yd^2.

- Calculate the unit weight of the emulsion (γ_E) by multiplying the specific gravity of the emulsion (G_E) by the unit weight of water (γ_W).

$$(\gamma_E) = (G_E \times \gamma_w)$$

$$(\gamma_E) = \left(1.010 \times 62.4\frac{lb}{ft^3}\right)$$

$$(\gamma_E) = 63.024\frac{lb}{ft^3}$$

BINDER CONSIDERATIONS

CHECKING APPLICATION RATES

***Example* – Checking Fog Seal Application Rate (Method A) (continued)**

- Convert the unit weight of the emulsion (γ_E) to lb/gal (γ_{Elb}) by dividing (γ_E) by (C_{f1}).

$$(\gamma_{Elb}) = \left(\frac{\gamma_E}{C_{f1}}\right)$$

$$(\gamma_{Elb}) = \left(\frac{63.024\frac{lb}{ft^3}}{7.5\frac{gal}{ft^3}}\right)$$

$$(\gamma_{Elb}) = 8.4\frac{lb}{gal}$$

- Convert (W_A) in lb/yd^2 to ($W_{A'}$) in gal/yd^2 by dividing (W_A) by (γ_{Elb}).

$$(W_{A'}) = \left(\frac{W_E}{\gamma_{Elb}}\right)$$

$$(W_{A'}) = \left(\frac{0.7\frac{lb}{yd^2}}{8.4\frac{lb}{gal}}\right)$$

$$(W_{A'}) = 0.08\frac{gal}{yd^2}$$

Check this value against the recommended application rates given in Table 7-1. For the given surface condition and dilution rate this application rate is acceptable.

BINDER CONSIDERATIONS	
CHECKING APPLICATION RATES	**Binder – Method B (Recommended for Random Checks)** ▪ Park the distributor on level ground and measure the number of liters or gallons of emulsion. ▪ Measure off a known distance for a test section. ▪ Have the distributor apply diluted emulsion to the test section. ▪ Park the distributor on level ground and re-measure the number of liters or gallons of emulsion. ▪ Make necessary adjustments to volume based on temperature corrections per Standard Specifications section 93-1.04. ▪ Subtract the number liters or gallons after application from the original number of liters or gallons to obtain the number of liters or gallons applied. ▪ Divide the number of liters or gallons applied by the number of square meters or square yards covered by emulsion to give the application rate in gal/yd^2 or l/m^2. ▪ If the distributor is not spraying the binder at the correct application rate, adjustments must be made to the controls and the process described above repeated until the correct application rate is achieved. Although this is the responsibility of the contractor, the inspector should verify that the distributor is spraying the binder at the correct application rate throughout the project.
PROJECT INSPECTION RESPONSIBILITIES	
BINDER APPLICATION	▪ Is building paper used to start and stop emulsion application for straight edges? ▪ Is the emulsion within the required application temperature range? ▪ Does the application look uniform? ▪ Are any nozzles plugged? ▪ Is there streaking on the applied emulsion? ▪ Are application rates randomly checked? ▪ Is the speed of the distributor adjusted to match that of the sand spreader (if used) and to avoid start-and-stop operations? ▪ Is the distributor stopped if any problems are observed?
TRUCK OPERATION	▪ Are the trucks staggered across the fresh fog seal coat to avoid driving over the same area? ▪ Do the trucks travel slowly on the fresh seal? ▪ Are stops and turns made gradually? ▪ Do truck operators avoid driving over exposed oil?

PROJECT INSPECTION RESPONSIBILITIES	
OPENING A FOG SEAL TO TRAFFIC	▪ Does traffic travel slowly — 25 mph (40 kph) or less—over the fresh seal until seal is broomed and opened to normal traffic? If not sanded, allow 2 hours before opening to traffic. ▪ Are reduced speed limit signs used when pilot cars are not used? ▪ Are pavement markings placed after brooming and before opening to normal traffic? ▪ Are all construction related signs removed when opening to normal traffic?
CLEAN-UP	▪ Is all loose (excess) sand from brooming operation removed from travel way? ▪ Are binder spills cleaned up?
REMOVAL OF EXCESS BINDER FROM SURFACE	
SAND APPLICATION	▪ Are enough aggregate trucks on hand to maintain a steady supply of sand to the spreader? ▪ Is clean dry sand being used? ▪ Does the sand application appear uniform? ▪ Is sand used only once?
BROOMING	▪ Does brooming begin as soon as possible after sand is applied? ▪ Is initial brooming done lightly with a rotary broom to distribute and set sand in surface? ▪ Is secondary brooming done to remove loose sand coated with excess binder?

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