



SECTION 12

RESTORATIVE SEALS USING EMULSIFIED RECYCLING AGENTS

12.1 Scope

This performance guide covers the use of rejuvenating agents for restorative seals and construction seals. It should be used as a guide in achieving successful results through proper construction practices and adequate knowledge and understanding of emulsions.

12.2 Definitions

12.2.1 Restorative Seal

A light spray application of dilute recycling emulsion, applied to an existing asphalt concrete surface which restores the chemical balance to the asphalt at the surface and some small depth below. This balance is lost from the heat of the hot mix plant, exposure to water and air, as well as deicing agents and other contaminants which primarily affect the surface asphalt. This seal may also help to seal hairline cracks and fill surface pores which develop due to aging.

12.2.2 Construction Seal

Light spray application of dilute recycling emulsion, applied to a newly constructed asphalt concrete surface which restores the chemical balance to the asphalt at the surface and some small depth below. This balance is lost primarily from the heat of the hot mix plant. This seal may also help to seal or prevent the formation of surface pores.

12.2.3 Dense Surface

Tight, relatively non-absorbent smooth-textured surface.

12.2.4 Open Surface

Open, relatively porous and absorbent, rough textured surface. This type of surface will require a higher rate of application to compensate for the emulsion which flows into the large voids and cracks. Most chip sealed surfaces are open surfaces.

12.3 Applicable Documents

12.3.1 ASTM Documents

- D70 Test Method for Specific Gravity of Semi-Solid Bituminous Materials
- D140 Sampling Bituminous Materials
- D244 Standard Methods of Testing Emulsified Asphalts
- D1754 Test Method for Effects of Heat and Air on Asphaltic Materials (Thin Film



Oven Test)

- D2170 Test Method for Kinematic Viscosity of Asphalts
- D 2171 Test Method for Viscosity of Asphalts by vacuum Capillary Viscometer
- D2042 Test for Solubility of Asphalt Materials in Trichloroethylene
- D2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)
- D2007 Test Method for Characteristic Groups in Rubber Extender and Processing Oils by Clay Gel Adsorption Chromatographic Method
- D2995 Practice for Determining Application Rate of Bituminous Distributors
- D5505 Clasifying Emulsified Recycling Agents

12.3.2 AEMA Documents

- *A Basic Asphalt Emulsion Manual (BAEM)*
- Recommended Performance Guidelines

12.4 Description of Work

This work shall consist of furnishing all labor, equipment, and materials, and in performing all operations necessary for the restorative or construction seal of asphalt concrete surfaces by the spray application of an appropriate recycling emulsion, diluted with water, complete, in accordance with the specifications, applicable drawings and subject to the terms and conditions of the contract.

12.5 Recycling Emulsion

- The emulsified rejuvenating agent must be homogenous, free-flowing at pumping temperature, and must conform to the requirements of **Table 12-1 Specification for Emulsified Recycling Agent** for ER-1.
- ER-1 is a material whose main function is to rejuvenate aged asphalt. The material is a petroleum derivative, and highly compatible with asphalts. It is classified by viscosity.
- Sampling shall be carried out in accordance with Method D140.
- Samples shall be stored in new, clean, airtight sealed containers as specified in Method D140 at a temperature not less than 40° F (4° C) until tested.
- Testing — The emulsion shall be tested in accordance with appropriate ASTM Methods.
- Normally this emulsion is diluted prior to application to reduce viscosity for spraying, to allow filling of small cracks or voids, and to more accurately apply very small quantities of residual material per square yard.
- For the restorative or construction seal, the emulsion is normally of the slow setting type in order to properly flow into and seal small cracks or porous surfaces.

12.6 Water

Water is normally used for diluting slow set emulsions for restorative seals. It should be clean, potable water, free from detectable solids or incompatible soluble salts.

Test for dilution incompatibility, whenever in doubt, by diluting the emulsion in the severest conditions anticipated (e.g., high dilution, cold water, hard water, high shear

pumps). No instability or coagulation should appear such as BB-sized particles. Consult the emulsion supplier if there are any questions.



12.6.1 Other Methods of Dilution

When water is not desirable for emulsion dilution, a small amount of compatible emulsifier solution can be used. The emulsion manufacturer is the one most familiar with the particular emulsion and must be consulted to determine specific method and materials for dilution.

12.6.2 Diluting the Emulsion

When the emulsion is to be diluted for spray application, the final product shall be a fluid, homogenous mixture. Care must be exercised to prevent hard or extremely cold water or emulsifier solution from chemically breaking or thermally shocking the emulsion. Dilution may be improved by pre-warming the dilution liquid to 25 to 50° C (77 to 122° F). Never add emulsion to water, always add water or other diluent to emulsion. Normal dilution for application is achieved by diluting 1 part emulsion to 1 part water (1 + 1). Other dilution rates are 2 + 1.

12.7 Storage and Handling

Diluted emulsions are normally not stored, unless weather or the like necessitates temporary storage. A diluted emulsion is more unstable than the original.

Suitable storage and handling facilities shall be provided for the emulsion, so as to:

1. Prevent contamination by water, oils or other liquids.
2. Prevent contamination by other incompatible emulsions.
3. Protect from freezing or boiling temperatures which break the emulsion and cause separation into asphalt and water.
4. Protect from local overheating by high temperature heating coils. Use of hot water is recommended for heating emulsion. Where steam, hot oil or direct fire must be used, controls must keep coil surfaces below 85° C (185° F).
5. Use bottom loading wherever possible or employ full length drop hose to eliminate foaming. Foaming may cause a volume gauge error due to inclusion of air from free fall.
6. Allow surface crust which forms on emulsion in storage to float without disturbance. Vertical tanks can help maintain constant and minimal surface area. Return lines into tanks should have outlets near the tank bottom and circulation should not free fall or disturb surface crust.
7. Reduce high shear which can break emulsions by enlarging clearances on new gear pumps by milling if necessary.
8. Prevent unnecessary circulation which can cause drop in emulsion viscosity or actual emulsion breakdown.
9. Do not agitate emulsion with forced air as it may cause the emulsion to break in the tank.

12.8 Equipment



12.8.1 Emulsion Distributor

It is the principal function of the distributor to apply emulsion uniformly in both transverse and longitudinal directions at the specified rate in L/m^2 (gal/yd^2). Failure to do so can result in streaking in which too much and too little emulsion alternate every few inches across the road surface.

Streaking usually results from incorrect positioning of the nozzles in the spray bar, from different nozzle sizes in the spray bar, from incorrect spray bar height, from damaged or nicked spray nozzles, by forcing more or less than the optimum quantity of asphalt emulsion through each spray nozzle, or from attempting to spray emulsion at too low a temperature so that it cannot fan out properly from the spray nozzles, and even by inability of the control mechanism to fully open the spray nozzles in one or more sections of the spray bar.

To avoid streaking, each nozzle in the spray bar of the asphalt distributor should be turned to make the constant angle with the longitudinal axis of the spray bar that is recommended by the manufacturer. All nozzles in the spray bar should be of the same size. The spray bar height should provide double or triple overlap of the asphalt binder being applied by the spray nozzles as recommended by the manufacturer. The distributor should be able to spray asphalt emulsion within ± 5.0 percent of the average application rate in the longitudinal direction and within ± 10.0 percent of the average rate of application for any 4-inch width in the transverse direction. A very simple and practical method for checking the rate of application of asphalt emulsion in both the longitudinal and transverse directions is provided by ASTM D2995.

For satisfactory application of emulsion, uniform pressure must be maintained in the spray bar. The optimum pressure discharges emulsion at a constant rate through each spray nozzle, (e.g., 15.1 L/min (4 gal/min)). Only at this constant rate of discharge does the emulsion fan out uniformly from each spray nozzle. Therefore, different rates of application of emulsion in L/m^2 (gal/yd^2) should be achieved by changing the forward speed of the distributor and not by changing the discharge rate in L/min (gal/min) from each spray nozzle.

Important accessory equipment for each asphalt distributor includes an accurate gauge, 150 mm (6 in.) in diameter or larger, to indicate pressure in the spray bar, an accurate tachometer to show pump speed in r/min, an accurate thermometer for registering the temperature of the asphalt emulsion in the distributor, a calibrated dipstick to enable liters (gallons) of emulsion per millimeter (inch) of depth to be read at any time, and a bitometer that has been calibrated to accurately measure the distance travelled and the speed in m/min (ft/min) when spraying.

12.8.2 Foreign or Objectionable Materials

All tools and equipment shall be clean of foreign or objectionable materials so as not to contaminate the emulsion. flushing and washing the distributor prior to commencing work is necessary.

The continuous cleanliness and safe, satisfactory condition of all tools and equipment are subject to the approval of the Director.



12.8.3 Calibration

At any time, the Engineer may require calibration of the emulsion distributor.

12.8.4 Operator

The distributor operator shall be experienced in setting and controlling the application rate of the emulsion.

12.9 Preparation of Surface

Existing surface shall be repaired as directed by the engineer prior to further construction. The emulsion will flow into the small cracks and seal them, but it cannot be expected to take the place of adequate repair of major deterioration of the pavement.

The surface shall be free from dust, loose or foreign matter and any objectionable material which would hinder adhesion of the emulsion. Parking lots or other areas with heavy oil drippings should be cleaned with detergent or by other methods prior to spraying with emulsions.

12.10 Application

12.10.1 Spraying

Emulsion applied by pressure distributor shall be applied at a uniform rate, without splattering or drilling from the spray bar, by using low pressure. Nozzle angle and spray bar height must be adjusted to insure correct spray pattern.

Distribution shall be commenced with a running start to insure a full rate of speed over the entire area, and to avoid local overapplication.

12.10.2 Application Temperature

Application temperature shall be 25 to 50° C (77 to 122° F) or as recommended by the emulsion supplier.

12.10.3 Application Rate

The diluted emulsion may be applied at a rate of from 0.14 to 0.44 L/m² (0.03 to 0.10 gal/yd²) as specified by the Director. The typical range of application for most projects is 0.22 to 0.36 L/m² (0.05 to 0.08 gal/yd²)

12.10.4 Objective of Restorative or Construction Seals

The objective for proper application of a restorative or construction seal is to apply a uniform coverage of emulsion, just sufficient to flow into and seal the pavement pores, small cracks, and voids against water and weathering. Ideally, the peaks of most aggregate particles should remain uncoated with rejuvenator to prevent reduction of skid resistance. Two or more successive applications of the respective proportion of the de-

sired total application can aid in preventing excess application. The distributor should be operated in opposite directions on each pass to minimize inconsistencies in spray pattern.



12.10.5 Over-Application

Upon over-application and at the discretion of the supervising engineer, a light cover of clean, fine sand may be applied onto the uncured seal at the rate of 3.3 to 5.4 kg/m² (6 to 10 lb/yd²) to provide for a safe, skid resistant surface. A pass of a pneumatic-tired roller should be made over this light sand dusting to firmly embed the fine sand. The seal should be allowed to completely cure before opening to traffic.

12.10.6 Spills

All spills, leaks, or other objectionable amounts of emulsion on the pavement shall be immediately removed by use of suitable absorbent material, such as fine sand, and disposed of properly.

12.11 Weather

Spray application of emulsions should be avoided prior to probable rainfall and shall not be applied during rain. High humidity will slow the emulsion break. Pavement and air temperatures should be above 10° C (50° F). With extreme hot, dry conditions, it may be advantageous to lightly dampen the surface to be sprayed with 0.68 L/m² (0.15 gal/yd²) water to prevent premature break of the emulsion.

12.12 Traffic Control

Traffic control during application shall be employed to protect the freshly sprayed emulsion until it is cured to a safe condition. Unnecessary pickup of the fresh emulsion by construction traffic shall be avoided. Traffic volume should determine the type and extent of control needed. Suitable methods shall be used, such as signing, barricades, flagmen, pilot cars, etc., to protect the construction and the public.

Table 12-1 Specification for Emulsified Recycling Agent



TESTS		ER-1	
ASTM Test		Min	Max
On Emulsion			
Viscosity, 50° C, SSF	D244		100
Sieve, %	D244		0.1
Storage Stability, 24hr. %	D244		1.5
Residue, by distillation, %	D244	65	
Cement Mixing	D244		2.0
Specific Gravity	D70	report	
Compatibility ¹	varies	report	
On Residue From Distillation			
Viscosity, 60° C, cSt	D2170	50	200
Saturates, %	D2007		30
Solubility in Trichloroethylene	D2042	97.5	
On RTFO² Residue			
RTFO, Wt. change, %	D2872		4

NOTES:

1. This specification allows a variety of emulsions, including high-float and cationic emulsions. The engineer should take the steps necessary to keep incompatible materials from co-mingling in tanks or other vessels. It would be prudent to have the chemical nature (float test for high float emulsions, particle charge test for cationic emulsions, or other tests as necessary) certified by the supplier.
2. RTFO shall be the standard. When approved by the engineer, the Thin Film Oven Test (ASTM D 1754) may be substituted for compliance testing.

