

# Rejuvenating Scrub Seal

## Sample Construction Specification Guideline

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## 1 Scope

The scope of this sample construction specification guideline is limited and intended to provide general information regarding the design, component material specification, application, inspection, measurement and payment of a Rejuvenating Scrub Seal.

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## 2 Description

A Rejuvenating Scrub Seal is an application of a rejuvenating asphalt emulsion scrubbed into the cracks and voids, followed by an application of aggregate for the purpose of extending the service life of a flexible pavement structure. A Rejuvenating Scrub Seal is recommended on flexible pavement exhibiting cracks too numerous to address with normal crack sealing methods and too severe to address with a chip seal.

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## 3 Materials

### 3.1 Asphalt Emulsion

Asphalt emulsion delivered to the project shall be accompanied by a laboratory certification of analysis. The asphalt emulsion shall be designated CMS-1PC and shall meet the following requirements:

Property	Test Procedure (AASHTO)	Specification	
		(min)	(max)
Emulsion Properties			
Viscosity, Saybolt-Furol, @ 77°F, SFS	T59	50	350
Storage, 24 hrs, %	T59		1
Oil Distillate, %	T59		0.5
Sieve Test, %	T59		0.1
Residue by Distillation <sup>(1)</sup> @ 350°F, %	T59	60	
Residue Properties from Distillation			
Penetration @ 4°C, 200g weight, 60 sec	T49	30	
Residue Properties from Low Temp Evaporation			
MSCR @ 52°C, I <sub>nr</sub> @ 3.2/kPa	ASTM D7405		4.0
Polymer Properties <sup>(2)</sup>			
Swelling in Rejuvenating Agent, % Max Weight Increase: 48 hrs	ASTM D471 Modified <sup>(2)</sup>		40
Tensile Strength (psi)	ASTM D412A Modified <sup>(2)</sup>	800	
Glass Transition Temperature (T <sub>g</sub> ) - Midpoint by DSC (°C)	ASTM D7426 Modified <sup>(2)</sup>	0	
Latex Density at 23°C (g/cm <sup>3</sup> )	ASTM D6937 Modified <sup>(2)</sup>	1.00	1.05
Latex pH	ASTM E70 Modified <sup>(2)</sup>	6.0	8.0
Test on Rejuvenating Agent			
Flash Point, COC, °F	ASTM D92	380	
Viscosity, 140°F, cSt	ASTM D2170	50	175
Saturate, %w	ASTM D2007		30
Asphaltenes, %w	ASTM D2007		1.0
Test on Residue from RTFO			
Weight Change, %w	ASTM D2872		6.5
Viscosity Ratio (RTFO Orig.)	ASTM D2170		3

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1. Exception to AASHTO T59: Bring the temperature on the lower thermometer slowly to 350°F plus or minus 10°F. Maintain this temperature for 20 minutes. Complete the total distillation in 60 plus or minus 5 minutes.
2. For modifications for Polymer Properties testing, refer to Appendix A Test Modifications.
3. The emulsion supplier shall receive quarterly certificates of analysis from both the polymer and rejuvenating agent manufacturers. The COAs will be provided to the agency upon request.

### 3.2 Recycling Agent

The manufacturer of the rejuvenating agent, through the emulsion supplier and the contractor, shall submit to the agency test results certifying that the material meets the specification listed in this document. The agency shall not accept test results dated more than 120 days from the date of the project start. At any time during the project, the agency may obtain, and have tested at agency expense, samples of the recycling agent being used in manufacturing of emulsion delivered to the project.

### 3.3 Latex Polymer

The manufacturer of the latex polymer, through the emulsion supplier and the contractor, shall submit to the agency test results certifying that the material meets the specification listed in this document. The agency shall not accept test results dated more than 120 days from the date of the project start. At any time during the project, the agency may obtain, and have tested at agency expense, samples of the latex polymer being used in manufacturing of emulsion delivered to the project.

### 3.4 Aggregate

The aggregate shall meet gradation requirements of ASTM section 800 for size 89 and shall be washed, hard, durable, clean rock such as granite, slag, limestone or other high-quality aggregate and free from coatings or deleterious material. All of the aggregate shall be crushed with 100% fractured faces. The aggregate shall have maximum loss of 35% when tested with the LA Abrasion procedure as defined by AASHTO T96. The maximum amount of flat and elongated aggregate with a ratio of 3:1 shall not exceed 18% as determined by ASTM D4791.

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## 4 Mix Design

A mix design shall be performed using The Modified Kearby Method or other design method as approved by the agency. The design shall be completed with materials representing those used on the project by a qualified laboratory and submitted by the contractor at least 5 days prior to the start of the project. The design shall indicate the target asphalt emulsion application rate at various pavement conditions including average daily traffic and surface texture.

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## 5 Equipment

### 5.1 Asphalt Distributor

The distributor shall be self-powered and capable of providing a uniform application rate of asphalt binder varying from 0.05-1.00 gal/yd<sup>2</sup> (0.23-4.5 liters/m<sup>2</sup>) over a variable width up to sixteen feet (4.88 m) in a single pass, include computerized application controls and be capable of heating material to 160°F (71.1°C). Nozzles on the distributor bar shall be fully operational and of the size suggested by the manufacturer to apply the intended application rate.

### 5.2 Aggregate Spreader

The aggregate spreader shall be self-propelled and supported by at least four tires on two axles capable of providing a uniform application rate of aggregate from 5-50 lb/yd<sup>2</sup> (2.7-27.1 kg/m<sup>2</sup>) over a variable width up to 16 feet (4.9 m) in a single pass. The uniformity of this machine shall not vary by more than 1lb/yd<sup>2</sup> (0.54 kg/m<sup>2</sup>). The aggregate spreader shall be equipped with the means of applying the aggregate to the surface with computerized application controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material.

### 5.3 Broom Sled

A scrub broom as described herein shall be used to scrub the emulsion after emulsion application and before the application of aggregate.

The scrub broom frame shall be constructed of metal and equipped with means to be attached to and pulled by the distributor truck.

The scrub broom must be equipped with a means of raising and lowering the scrub broom when desired. It shall be towable in the elevated position. The weight of the broom sled assembly shall be adjustable related to the amount carried by the broom heads themselves such that, regardless of application rate, the broom sled carries an excess of emulsion in front of the broom heads across the width of the area to be treated while containing the emulsion inside of the broom sled frame and not outside of the intended width of the treatment.

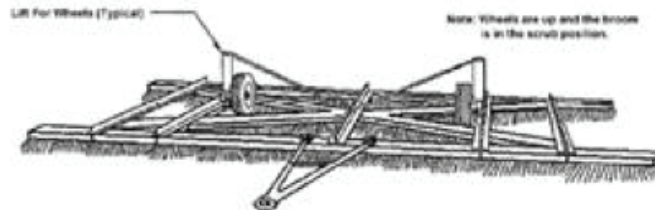
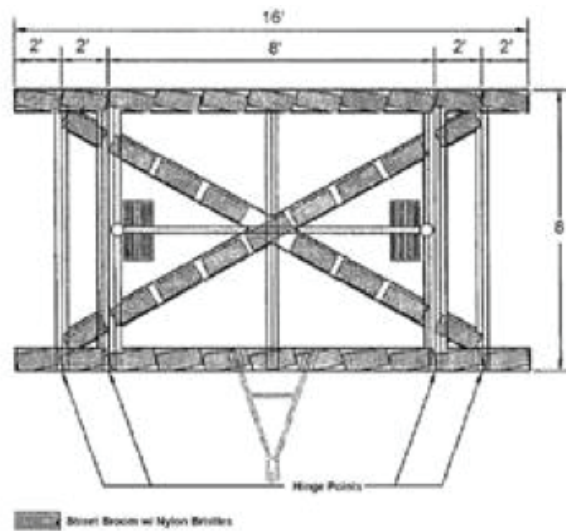
The main body of the scrub broom shall have a frame size as shown in the drawing below. The nearest and furthest members, paralleling the back of the distributor truck, and diagonal members shall be equipped with street brooms. The leading member and the trailing member shall have broom heads angled at 10 to 15 degrees off the centerline of the supporting member. The diagonal members shall have broom heads attached in line with the centerline of the supporting member. Each individual street broom attached to the scrub broom assembly shall be 3.5 inches wide x 6.5 inches high x 16 inches long and have stiff nylon bristles. Bristle height is to be maintained at a minimum of five inches (5").

The broom sled shall be equipped with hinged wing assemblies attached to the main body not to exceed 4.5 feet per side, with diagonals and equipped with the identical street brooms as described herein.

The purpose of the maximum rigid frame width and the hinged wing extensions is not only for maximum width of 16 feet but to maintain the scrubbing process evenly as contours and cross-sections change across the existing road surface. A means or method of controlling the broom sled, causing it to track evenly behind the distributor in curves and on cross slopes, is required.

Although a broom sled design diagram is included in this document, any alternate broom sled design considered by the agency to achieve the purpose of filling the cracks with emulsion is acceptable.

As a part of the test strip, the design of the broom sled, as specified or of alternate design, will be evaluated and is required to be proven effective as described herein.



**Scrub Broom**

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## 5.4 Rollers

A minimum of two 10-16 ton (9.1-14.5 metric tons) self-propelled pneumatic tired rollers shall be used on the project unless otherwise requested by the agency. Tire pressure shall be specified by the manufacturer and shall not vary more than plus or minus 5 psi. Depending on the speed of the Rejuvenating Scrub Seal operation and the width of coverage, additional rollers may be required. At no time shall the rollers travel more than 10 mph (16.1 kmph).

## 5.5 Broom

Self-propelled four wheeled rotary mechanical brooms and/or vacuum brooms capable of operating in both forward and reverse are recommended. Brooms should be in good condition and meet applicable environmental standards.

## 5.6 Aggregate Handling Equipment

Standard bucket loader capable of transferring aggregate to the haul trucks is required. Standard rear discharge dump trucks of sufficient number to maintain adequate production relative to the size of the project are required.

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# 6 Equipment Calibration

## 6.1 Asphalt Distributor

The distributor shall be calibrated by applying asphalt emulsion for a minimum 300 foot (91.4 m) continuous section. The amount of material distributed shall be within 5% of the intended application rate at the intended width to be used on the project and shall be verified by use of the strapping stick as supplied by the equipment manufacturer. Neither a visual gauge indicating volume nor the computer readout shall be used as a calibration method.

Asphalt emulsion application rate is expressed in gal/yd<sup>2</sup> (L/m<sup>2</sup>).

Alternate calibration methods may be utilized as approved by the agency.

## 6.2 Aggregate Spreader

The aggregate spreader shall be calibrated using aggregate intended to be used on the project. Place two square tarps (typically supplied with the spreader), that measure exactly 1 yd<sup>2</sup> (1 m<sup>2</sup>), adjacent to each other and in front of the spreader. Allow room for the spreader to reach operating speed and discharge aggregate while passing over the tarps. Carefully collect each tarp at the corners and, using a hand held scale (typically supplied with the spreader), determine the weight of the aggregate on each. The weight should not vary by more than 5% between tarps. Aggregate spread rate is expressed in lb/yd<sup>2</sup> (kg/m<sup>2</sup>).

Alternate calibration methods may be utilized as approved by the agency.

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## 7 Test Strip

Prior to the beginning of the project, the contractor may be required to perform a test strip in a suitable area such as a parking lot or staging area to assure the materials, contractor personnel and equipment are suitable to produce a satisfactory Rejuvenating Scrub Seal. The location for the test strip shall be approved by the owner. The test strip may be conducted as part of the calibration procedure and may be considered as part of the project.

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## 8 Weather

The Rejuvenating Scrub Seal shall not be placed when rain is possible prior to curing of the product or when freezing conditions are expected within 24 hours of application. Both ambient temperature and roadway surface temperature in all areas shall be minimum 50°F (10°C) and rising before beginning application.

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## 9 Traffic Control

Prior to start of the project, a traffic control plan shall be developed to address all aspects of traffic control, including without limitation, coordination with local officials and traffic control equipment and methods. The traffic control plan is intended to promote controlled traffic flow through the project in order to protect the safety of the contractor and owner personnel, the public, and the product. The traffic control plan shall remain in place until the product has sufficiently cured to withstand traffic without damage. Any damage to the newly applied Rejuvenating Scrub Seal due to construction traffic or the premature release of traffic shall be repaired to the satisfaction of the owner at the contractor's expense.

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## 10 Surface Preparation Control

### 10.1 General

Immediately prior to applying the Rejuvenating Scrub Seal, the pavement surface shall be cleared of all loose material, silt spots, vegetation, and other objectionable material. If water is used, cracks shall be allowed to dry thoroughly before applying the asphalt emulsion. Manholes, valve boxes, drop inlets and other service entrances shall be protected from the asphalt emulsion by a suitable method. Prior to application of the Rejuvenating Scrub Seal, Thermoplastic striping should be roughened or removed, without damaging the integrity of the existing pavement, unless one or more of the following factors are identified:

- The application is not intended to be the final wearing course.
- The striping is significantly worn and/or cracked.
- The application is on a low volume route.
- Application history and/or experience indicate the striping is not a concern.

The owner shall approve the surface preparation prior to application of the asphalt emulsion.

## 10.2 Cracks

Cracks wider than 0.25 inches (0.64 cm) should be treated with an approved crack sealer 30 days prior to application of the Rejuvenating Scrub Seal.

## 10.3 Patching

Prior to application, all failed pavement sections should be removed and patched using accepted best practices. The perimeter of excavated areas should be milled or saw cut to form a neat vertical face. Unstable areas of sub-grade should be back filled with well-graded and compacted aggregate and filled flush with the pavement surface with an appropriate asphalt aggregate mixture. Patching should be completed 30 days prior to application of the Rejuvenating Scrub Seal. Patches may require an individual application of asphalt emulsion prior to the full width application.

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# 11 Application

## 11.1 Asphalt Emulsion

The asphalt emulsion shall be applied by means of a pressure distributor. Application shall be a uniform, continuous, full coverage spread, and under such pressure as to thoroughly coat the surface at the specified rate. The temperature of the asphalt emulsion during application shall be maintained between 140°F-180°F (60°C-82.2°C). All nozzles within the intended width of spray shall be free of clogs and operating properly applying a full fan of asphalt emulsion to the pavement. At any time the nozzles are not functioning properly application is to be stopped immediately and repairs made to the equipment. The width of the emulsion application shall be no greater than the width of the aggregate spreader except where additional passes are required then the emulsion shall be four inches beyond the aggregate spread at a 50% application rate. At no time shall the emulsion be allowed to break, chill, set up, harden, or otherwise impair the aggregate retention before the aggregate has been properly applied and rolled.



## 11.2 Broom Sled

The broom sled shall be attached to the distributor in such manner as not to interfere with the distributor operation. The broom sled shall be adjusted to allow for even distribution of weight across the broom heads. The broom sled shall contain all emulsion applied by the distributor and carry an excess amount or wave of material ahead of the broom heads that will be forced into the cracks and voids by the mechanical forces of forward motion and downward pressure of the broom sled.

## 11.3 Aggregate

The aggregate shall be spread evenly onto the asphalt emulsion, as soon as possible and within 2 minutes, within 10 percent of the application rate specified in the mix design. Spreading shall be accomplished in such a manner that the tires of the trucks and aggregate spreader do not contact the newly applied asphalt emulsion. The width of the aggregate spreader shall be equal to the width of the emulsion spread, except where additional passes are required. Areas, which are deficient in aggregate, shall be covered immediately with additional material.

## 11.4 Rolling

Initial rolling shall begin immediately after the application of aggregate. Rollers shall work in tandem and complete a minimum of three passes with a sufficient overlap. Should the rolling operation be delayed, the aggregate and emulsion application shall be halted until the operation regains proper sequencing and timing. The maximum speed of the rolling operations shall be 10 mph (16.1 kmph).

## 11.5 Sweeping

Within 24 hours of curing, excess aggregate shall be swept from the roadway and adjacent areas. High traffic areas may require sweeping prior to release of traffic control. A minimum of 6 hours is required for the Rejuvenating Scrub Seal, to retain aggregate in normal conditions. Sweeping shall be delayed if damage to the seal occurs as a result of the broom operation.

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# 12 Material Storage and Handling

## 12.1 Asphalt Emulsion

Asphalt emulsion stored on the jobsite must be agitated and heated using the distributor prior to use. Stored emulsion shall be inspected by the contractor for suitability prior to use on the project. The contractor shall comply with all material handling, storage, and safety requirements outlined in any applicable MSDS or other product label.

## 12.2 Aggregate

Aggregate intended for use on the project shall be maintained in such manner as to protect it from contamination by debris and excess moisture. Large or oversized particles shall be removed from the aggregate by screening or other acceptable method prior to use on the project.

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## 13 Inspection

Assure all equipment operations are functional. The nozzles shall be clean and producing a consistent fan of material providing full and complete coverage of material across the asphalt surface with no overlap or excessive material. Assure the aggregate is evenly applied within design target and with no bare spots. Assure emulsion is within required temperature range prior to application. Assure operation of broom sled is providing the necessary wave of excess asphalt emulsion to fill large cracks and voids. Assure broom heads are not excessively worn. Assure aggregate is not extremely wet or dusty. Assure the Rejuvenating Scrub Seal is sufficiently cured prior to brooming of excessive aggregate. Document job progress reporting; weather conditions, material test results, application rates, quantities used and the location of any areas of concern and reason for concern. Assure traffic control measures are in place and are adequate to satisfy all safety and product requirements.

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## 14 Measurement

The Rejuvenating Scrub Seal shall be measured in square yards (square meters) covered.

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## 15 Payment

Payment shall be in consideration of all materials, tools, labor and other items as necessary to complete the project as required by the plans. The Rejuvenating Scrub Seal shall be paid for by one of the following options:

By the square yards (square meters) covered.

By the gallons (Liters) of emulsion and ton of aggregate used.

# APPENDIX A

## Test Modifications

ASTM D471 Standard Test Method for Rubber Property - Effect of Liquids: Modifications for Polymer Testing, Resistance to Swelling

1. Using a syringe, place 0.8 gm of latex into a 18 mm diameter DSR mold.
2. Allow the sample to dry at ambient lab conditions (air conditioned) on the bench for 72 hours. Sample should be easily removable from the mold.
3. Take the "button" out of the mold and place the sample into a forced air oven at 40°C (104°F) for 48 hours (on release paper). If at the end of the ambient dry, the sample sticks to the mold, place it into the oven and check it after 1-2 hours.
4. After 48 hours cool and weigh the sample to the nearest 0.0001 gram and record the weight.
5. Put ½ inch of Rejuvenating Agent into a 3 oz penetration tin.
6. Place the "button" on the Rejuvenating Agent, and add another ½ inch of Rejuvenating Agent, so that the "button" is covered.
7. Put the cap on the penetration tin and place it into the 40°C oven for 48 hours.
8. Remove the "button" from the Rejuvenating Agent, blot surface of the "button" to remove excess Rejuvenating Agent, cool the "button" to room temperature and weigh it.
9. Calculate weight gain of the "button," express as %.

ASTM D412A Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension: Modifications

1. To prepare the polymer film, dilute the waterborne polymer to 40% Total Solids Content and pour 57 g into a Teflon or silicone release mold of dimensions 7" X 7" X ¼."
2. Allow to dry at 23°C (73°F) and 50% RH (controlled conditions) for 7-10 days total time, during which time the film should be flipped around once, preferably after 3 or 4 days. The film should be transparent in the end.
3. To drive out any residual water, place the film in an oven at 50°C for 30 min. Dried film thickness should be 25 mil +/- 5 mils. Discard films <20 mil.
4. Cut out dumbbell-shaped test specimens of dimension 75 mm total length, 25 mm mid-section (L) and 4 mm width of mid-section.
5. Grip in Instron machine with gap size 1 inch, use 8 inch/min cross-head speed.

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ASTM D7426 Standard Test Method for Assignment of the DSC Procedure for Determining T<sub>g</sub> of a Polymer or an Elastomeric Compound: Modifications

Use between 3-30 mg dry polymer. Instrument used is TA Q2000. Differential Scanning Calorimeter (DSC). Heating rate is 20°C/min.

ASTM D6937 Standard Test Method for Determining Density of Emulsified Asphalt: Modifications

Replace “Emulsified Asphalt” with “Latex” in text of test method. The testing temperature used should be 25 +/- 3°C. The calculation in Section 7 should be as follows:

Calculation:

$$D = (W_f - W_t) * 0.1$$

$$S.G. = D / 8.337$$

Where: W<sub>f</sub> = Weight of filled cup (g)

W<sub>t</sub> = Weight of empty cup (g)

ASTM E70 Standard Test Method for pH of Aqueous Solutions with the Glass Electrode: Modifications

1. A pH meter with automatic temperature measurement should be used in the evaluation with a calomel cell assembly or combination electrode. Calibration should be made using the procedure with the pH meter, according to ASTM method, prior to testing the pH of the latex. In Section 9, the procedure for measuring pH of the latex should be as follows:
  - a. Place the electrode and probe into the dispersion that is to be measured and swirl the sample cup or beaker gently. (You may also use the probe in a stirring motion.)
  - b. Wait for the reading to stabilize (usually less than a minute) and read/record this value. Note the temperature if not utilizing an ATC probe.
  - c. Take the Electrode and ATC probes from the sample and rinse thoroughly with de-ionized water. Pat dry and place back into appropriate solution recommended by electrode manufacturer for storage.