

Spray on Rejuvenator Synthesis

NRRRA PREVENTIVE MAINTENANCE TEAM

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16. Abstract (Limit: 250 words) Spray on rejuvenators, designed to penetrate into the asphalt pavement to a certain depth, can be applied to hot mix asphalt (HMA) pavement surfaces, serving as a cost-effective method intended to reverse the effects of aging. Rejuvenators strengthen the HMA material at the surface to resist the detrimental effects of exposure to sun, water, and air. To achieve optimal performance, it is recommended that rejuvenators be applied to roadways in good condition as a preventive maintenance treatment. There are two major types of spray applied rejuvenators: petroleum-based and bio-based. The purpose of this project is to guide the research need statement for an upcoming research project on test sections investigating type of rejuvenating products, laboratory and performance testing, allowable or acceptable friction values, and pavement marking reflectivity. This synthesis includes a summary of experiences from various agencies and industries on the use of spray on rejuvenators. A literature review was performed and includes but is not limited to the type of rejuvenators used, application rate, type of testing conducted to evaluate the effectiveness of a spray on rejuvenator, and specifications.			
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SPRAY ON REJUVENATOR

FINAL REPORT

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This report represents the results of research conducted by the authors and does not necessarily represent the views or policies of the Minnesota Department of Transportation or WSB. This report does not contain a standard or specified technique.

The authors, the Minnesota Department of Transportation, and WSB do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to this report.

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CHAPTER 1: BACKGROUND

1.1 INTRODUCTION

Hot mix asphalt (HMA) pavements age over time, and due to oxidative age hardening and weathering from ultraviolet rays and water, they thereby tend to become brittle. Spray on rejuvenators, designed to penetrate into the asphalt pavement to a certain depth, can be applied to HMA pavement surfaces (**Figure 1.1**), serving as a cost-effective method intended to reverse the effects of aging. Rejuvenators strengthen the HMA material at the surface to resist the detrimental effects of exposure to sun, water, and air. To achieve optimal performance, it is recommended that rejuvenators be applied to roadways in good condition as a preventive maintenance treatment. Spray on rejuvenators, when applied to good roadways enhance the durability of the pavement surface.



Figure 1.1 Application of spray applied emulsions.

1.1.1 Petroleum-Based Rejuvenators

Asphalt is essentially made up of two distinct components, maltenes and asphaltenes (Durante, n.d.). Asphaltenes are hard, brittle, and insoluble components in asphalt. They are not as highly reactive as maltenes thus furnishing asphalt binder its structure. Maltenes are volatile in nature and are susceptible to degradation by oxidation. They play the role of maintaining strength and flexibility.

Using adsorption chromatography in the presence of an acid reagent, maltenes can be further fractionated into four distinguishable sub fragments, which are polar compounds (PC) or nitrogen bases, first acidaffins (A_1), second acidaffins (A_2), and saturates (S) or paraffins (Durante, n.d.).

With exposure to sun and weather, asphaltene content increases over time while maltene content decreases. Volatilization during manufacturing and oxidation in the field are the main factors contributing to this volatilization and pavement failure. The flexibility and adhesion properties of the asphalt binder material could be restored if the maltene content could be replaced.

Petroleum-based rejuvenators can be applied to the surface of the roadways to reverse the effects of pavement aging by essentially rebalancing the ratio of maltenes to asphaltenes.

1.1.2 Bio-Based Rejuvenators

Bio-based rejuvenators have been gaining popularity in recent years due to the environmentally friendly aspects of the products. They are sourced from different natural ingredients such as soybeans, oranges, corn and other plant-based ingredients that do not contain maltenes. Bio-based rejuvenators are intended to provide similar rejuvenating benefits to the pavement as petroleum-based rejuvenators. However, bio-based rejuvenators employ an agricultural medium to deliver the polymers to the pavement surface (Barr, Cammarata, Rivera, Walck, & Waters, 2018).

Unlike petroleum-based rejuvenators, bio-based rejuvenators do not restore the maltene content in the pavement, but they use an agricultural medium to restore oxidized pavement. The chemical components and compositions of bio-based rejuvenators are often not known as industry producers consider them a trade secret.

1.2 WHY NRRRA MEMBERS WANTED THIS

1.2.1 NRRRA Members Involved

The eight state agencies that are currently involved in the spray on rejuvenators synthesis are the California Department of Transportation (Caltrans), Illinois Department of Transportation (DOT), Iowa DOT, Michigan DOT, Minnesota DOT, Missouri DOT, North Dakota DOT, and Wisconsin DOT.

1.2.2 Why This Effort is Being Done

The purpose of this project is to guide the research need statement for an upcoming research project on test sections investigating the type of rejuvenating products, laboratory and performance testing, allowable or acceptable friction values, and pavement marking reflectivity.

CHAPTER 2: LITERATURE REVIEW

An online survey was distributed across the eight state agencies to collect information on spray on rejuvenators. Additionally, a literature search was performed through the Transport Research International Documentation (TRID) database.

2.1 PETROLEUM-BASED REJUVENATORS

Durante (n.d.) states that the effectiveness of maltene replacement has been proven through already completed studies. These studies have shown that maltene-based rejuvenators “return molecularly exact, depleted chemicals into the asphalt matrix”. These rejuvenators, when applied to new pavements within their first two years of construction, helped to prolong pavement life. The first application serves to replenish maltene content lost during asphalt mixing. Ideally, these pavements only need to be resprayed with rejuvenators three to five years later or as needed depending on the conditions of the pavements. These reapplications serve to replenish maltene contents lost due to weathering and oxidation.

2.1.1 Type of Products

Descriptions of the products were obtained from the official webpages of the suppliers. The NRRRA is not affiliated with any of the products listed. The advertised benefits are solely for reference and do not represent NRRRA’s stance on the products. Specifications for each type of products, if available, can be found in the **Appendix A**.

CMS-1PF

<https://ergonasphalt.com/wp-content/uploads/2013/06/Fog-Seals.pdf>

CMS-1PF is a hybrid emulsion containing polymer-modified asphalt base. It restores lost binder and assists in increasing tracking resistance and enhancing durability. It usually cures within 1.5 hours.

CRF® RESTORATIVE SEAL

<https://tricorrefining.com/crf.php>

CRF® is a blend of petroleum oil and water using a cationic emulsion. This product is designed to fill the surface voids with emulsion and provide retention to the sand applied to it.

GSB-88®

<https://www.asphaltsystemsinc.com/product-overview.html>

GSB-88® is a gilsonite-based sealer and is an environmentally-friendly product certified by GreenCircle®. This product has been approved by the Federal Aviation Administration (FAA) to be applied on airfields to mitigate pavement raveling. Loose aggregate and debris released from the pavement as a result of raveling may cause damage to the jet engines. This product is also applied on roadways.

PASS® QB

<http://www.westernemulsions.com/pass-qb.php>

Pass® QB is a rejuvenating seal applied to seal low severity distress cracks, introduce new asphalt to the surface course, and reverse the effect of oxidation to delay the degradation of the pavement. It contains a blend of asphalt, rejuvenator oil, and polychloroprene latex polymer.

RAVEL CHECK®

<https://www.uniquepavingmaterials.com/products-retired/pavement-preservation-products-unique/>

Ravel Check® is an asphalt-based emulsion with penetrating chemistry and asphalt resins, designed to rejuvenate and restore pavements that have issues related to weathering and oxidation.

RECLAMITE®

<https://tricorrefining.com/reclamite.php>

Reclamite® is a maltene-based cationic petroleum emulsion developed by the Golden Bear Oil Company in 1960. It is designed to penetrate the pavement surface to assist in restoring maltene contents and enhance the durability of the pavement surface.

REGENX®

<https://blacklidge.com/products/regenx/>

ReGenX® is an age-regenerating surface treatment that reverses effects of asphalt oxidation and when applied as routine treatments helps to extend the life of the pavement. This product does not require re-stripping after application. Technical and safety documents were at the stage of development.

REJUVASEAL®

<http://www.rejuvaseal.com/rejuvaseal/what-is-rejuvaseal>

RejuvaSeal® is made from coal tar, aromatic oils, and specialty solvents designed to revitalize, seal, and protect the asphalt pavements. This product penetrates the pavement surface and restores the binder in aged asphalt pavements. Agencies should check the legality in respective states prior to using this coal tar-based product.

2.2 BIO-BASED REJUVENATORS

2.2.1 Type of Products

Description of the products was obtained from the official webpage of the suppliers. The NRRRA is not affiliated with any of the products listed. The advertised benefits were solely for reference and do not represent NRRRA's stance on the products.

ANOVA

<https://www.cargill.com/bioindustrial/anova/asphalt-rejuvenators>

Anova has been incorporated into recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) mixtures. It can also be used as rejuvenating asphalt emulsion for surface seals.

BIORESTOR®

<https://biorestor.com/>

Biorestor® is a restorative asphalt modifier developed with bio-based oils with synthetic polymer modification. It helps to reduce cracking and raveling and increase flexibility and penetration of the asphalt.

DELTA MIST™

<https://collaborativeaggregates.com/deltamist/>

Delta Mist™ is a plant-based rejuvenator based on the original Delta S technology formulated by the Warner Babcock Institute for Green Chemistry (WBI). This product penetrates the surface up to 3/8-inch, which helps to restore oxidized binder and decrease the amount of lost fines and aggregates.

<https://biospantech.com/products/replay/>

RePlay™ is 88 percent bio-based and contains soy and other agricultural oils, with nine polymers introduced. This product reverses the aging of the pavement binder from 3/4- inch up to 1 1/4-inch from the pavement surface. It cures in 30 minutes or less and it is non-toxic. There is no need to restripe the pavement after the application.

2.3 RESEARCH STUDIES

2.3.1 Evaluation of Rejuvenating Fog Seals (National Center for Asphalt Technology (NCAT) Test Track – Mississippi DOT and Tennessee DOT)

Seven different products as shown in **Table 2.1** were applied on a pavement layer with an asphalt content of 6.8 percent over a gravel aggregate base. This section was built in 2012 for the Test Track. Tests performed were based on the modification of the [Federal Aviation Administration’s procedure P-632 \(Asphalt Pavement Rejuvenation\)](#). Rheological properties of the extracted binder were examined two and four weeks after the application of the rejuvenating products. A dynamic friction test was also conducted after 3, 24, and 96 hours of applications. Another friction test was also performed after traffic simulated with the NCAT Three Wheel Polishing Device.

Table 2.1 Rejuvenators information obtained from the NCAT screening study (Source: NCAT, 2019).

Product	Application Rate (gallon per square yard)	Dilution Rate
CMS-1PF	0.08	30% residual
ReGenX®	0.07	2:1
RejuvaSeal®	0.06	100% residual
Delta Mist™	0.10	30% residual
Biorestor®	0.03	1:1
RePlay™	0.015	100% residual
Reclamite®	0.08	1:1

Products were ranked, where Grade A representing the best performing products, based on criteria as shown in **Table 2.2** such as rheological properties and friction test results. However, the results may vary depending on the pavement binders, aggregates, and mix designs.

Table 2.2 Rejuvenators performance-based classification as stated in the NCAT screening study (Source: NCAT, 2019).

Grade	Product
A	Biorestor®
	RePlay™
B	ReGenX®
	Delta Mist™
	Reclamite®
C	CMS-1PF
	RejuvaSeal®

FAA specifications could be used to provide guidance in evaluating the rheological and friction properties of the rejuvenators.

2.3.2 Evaluation of Rejuvenators and Surface Sealing Products to Extend Asphalt Pavement Life (Missouri DOT – TR201720)

The objective of the research was to extend the life of a pavement by improving the rheological properties of the mix or binder, decreasing the permeability of the pavement, and reducing the amount and severity of cracking or joint deterioration. Another goal of the research conducted by the Missouri DOT was to maintain the pavement integrity by maintaining friction and durability.

Test sections were located on Route N in St. Charles County. The site location is a two-lane roadway with an Average Daily Traffic (ADT) of 4,500. The surface layer is a 1.75-inch thick BP-1 mix laid in 2014, with an average pavement thickness of 9.25 inches. Existing distresses observed were minor block cracking and longitudinal cracking.

Products applied were Biorestor®, Ravel Check®, Reclamite®, and CRF® (**Table 2.3**). Binder properties were tested prior to product application, and all sections had a MSCR grade of PG 64-22E. The tests conducted included field permeability tests in accordance with internal spec (Missouri DOT TM-83), mainline visual surveys, friction testing in accordance with ASTM standard E274 – FN 40R. All tests were conducted at pre-treatment, 30-day, 6-month, 1-year, and 2-year intervals.

Table 2.3 Rejuvenators information obtained from the Missouri DOT rejuvenators study (Source: Missouri DOT, 2019).

Product	Application Rate (gallon per square yard)	Blotter Material
Biorestor®	0.01	None
Ravel Check®	0.04	None
Reclamite®	0.02	Yes
CRF®	0.08	Yes

Existing pavement was relatively impermeable with a permeability of less than 0.5 foot per day, thus the 1-month permeability result was inconclusive. Rejuvenator properties were tested in accordance with **Table 2.4**.

Table 2.4 Rejuvenators chemical component requirements as specified the Missouri DOT rejuvenators study (Source: Missouri DOT, 2019).

Test on Residue from Distillation	Minimum	Maximum	Test Method
Viscosity _{60°C} (cST)	1000	4000	ASTM D2170
Maltene Distribution Ratio, MDR: $\frac{(Polar\ Compounds)+(First\ Acidaffins)}{(Saturates)+(Second\ Acidaffins)}$	0.7	1.1	ASTM D2006-70
$\frac{(Polar\ Compounds)}{(Saturates)}$, PC/S Ratio	0.5	-	
Percentage of Asphaltenes (%)	-	14.0	

Ravel Check®, Reclamite®, and CRF® were observed to visually fill cracks, but not Biorestor®. **Table 2.5** showed that Biorestor®, Reclamite®, and CRF® showed acceptable percentage of asphaltenes, and only the CRF® showed an acceptable maltene distribution ratio. Biorestor® and Reclamite® had friction numbers (2 months after application) close to the number prior to treatment, within 3 percent. The Biorestor® and Reclamite® fulfill the criteria acceptable percentage of asphaltenes and friction testing (2-month after application)

Table 2.5 Test results as shown in the Missouri DOT rejuvenators study (Source: Missouri DOT, 2019).

Product	Percentage of Asphaltenes (%)	MDR	PC/S Ratio	2-month Percent Decrease in Friction (%)
Biorestor®	< 0.1	N/A	N/A	-2.9
Ravel Check®	23.0	1.4	3.4	-27.5
Reclamite®	1.8	1.4	5.2	-2.0
CRF®	0.24	0.9	1.8	-23.6

Note: Highlighted cells showed acceptable test results.

2.3.3 Long Range Paving Plan – Appendix C Resurfacing and Pavement Preservation Treatments (Metropolitan Government of Nashville and Davidson County, Tennessee)

Metro Nashville has conducted evaluations on products including Reclamite®, GSB-88®, RejuvaSeal®, PASS®, and RePlay™. Pass® produced satisfactory results thus the Metro has adopted this product into its preservation program. Both GSB-88® and RePlay™ are under the evaluation of Tennessee DOT. GSB-88® took a long time to cure, which would cause a larger impact on traffic. RejuvaSeal® had a strong coal tar smell, which could raise concerns if it is applied on residential streets. Reclamite® has been adopted by the Metro on 2- to 3-year old pavements with an overall condition index greater than 80.

2.3.4 Nontraditional Fog Seals for Asphalt Pavement: Performance on Shoulder Sections in Minnesota (MnDOT)

Two bio-based sealers, RePlay™ and Biorestor®, were applied on bituminous shoulder sections that were less than two years old. The shoulders were originally paved using a PG binder of 58-34.

Both products were evaluated using the Fourier Transform Infrared (FTIR) absorption spectroscopy methods. The profiles of RePlay™ and Biorestor® were found to share similarities. These products were not compared in terms of their binder properties as similar test results were expected.

Retro reflectivity testing for average post-treatment showed that under the same application rate of 0.02 gallon per square yard, RePlay™ had a higher reduction in retro reflectivity (62 percent reduction) than Biorestor® (41 percent reduction). However, both products had the same retro reflectivity recovery, which was approximately 1,600 truck passes.

Dynamic Friction Tester (DFT) runs were performed in accordance with ASTM E1911 at one and four hours after the applications. Friction numbers of sections treated with RePlay™ decreased by 14 percent and sections treated with Biorestor® decreased by 11 percent. Friction measurements obtained during year three on sections where RePlay™ and Biorestor® applied showed recovered friction performance similar to the control section.

2.3.5 Spray Applied Emulsion Preventive Maintenance Treatments: FHWA Research Study

Under the U.S. Federal Highway Administration (FHWA) Spray Applied Emulsion Preventive Maintenance Treatments research study, the rejuvenators applied were Pass® QB, CRF®, and Reclamite®. Test sections were spread out in locations across the states to determine the effects of climate, traffic volume, roadway surface, and the timeframe between the roadway being constructed and the application of a rejuvenator have on the performance.

Friction testing was performed using the Circular Texture Meter (CTM) in accordance with ASTM E-2157 and Dynamic Friction Tester (DFT) in accordance with ASTM E-1911 after the emulsions were cured. Sections applied with Reclamite® and Pass® QB had friction numbers lower than control sections, however, Pass® QB showed a higher decrease in friction after application as compared to Reclamite®. Permeability tests were run not just on the surface of the cores, but on the complete cores. The results of which showed that Pass® QB had a lower permeability than Reclamite®. In other words, Pass® QB sealed the pavement surface better than Reclamite®.

Dynamic Shear Rheometry (DSR) tests were conducted on binders extracted to determine the complex modulus, G^* , which indicates the softening of the surface materials. Reclamite® had the highest impact on softening the surface, followed by CRF® and Pass® QB. The results correlated to the rejuvenator content in the products. Reclamite® is a rejuvenator oil thus contains the highest rejuvenator content as compared to CRF® and Pass® QB which contain blends of rejuvenator oil with asphalt.

Dynamic Creep Tests were carried out to determine the rheological properties of the thin specimens by measuring the mixture stiffness. CRF[®] showed the lowest stiffness, followed by Reclamite[®] and PASS[®] QB.

The Static Bending Test using the Bending Beam Rheometer (BBR) was performed to obtain the stiffness and m-value, which indicates the low-temperature phase angle. These parameters help to determine the hardening of asphalt pavements. Reclamite[®] and CRF[®] reduced the low temperature stiffness, but they also reduced the m-value. This result contradicted the expectations that softening the asphalt at low temperature would improve its relaxation properties. However, any conclusions made from the BBR test had insufficient statistical confirmation due to sparse data.

Findings showed that there was a significant softening of the surface layer when products that contain a higher rejuvenator content were applied. The softening of the in-place asphalt and alleviating the skid issues are dependent on the ability of the rejuvenator to penetrate the pavement surface.

CHAPTER 3: SPECIFICATIONS

In the Asphalt Rejuvenators study (Boyer, 2000), it has been stated that agencies should implement a performance type specification, of which the outcomes would be to help to prevent unacceptable friction results and performance characteristics. It would not be recommended to specify application rate since each rejuvenator performs differently according to the study. However, it is ultimately the agency’s decision if a rate should be specified by the agency or by the manufacturer.

Three specifications covered in this synthesis include sources from the Federal Aviation Administration (FAA), the Florida Pavement Preservation Council (FPPC), and the Maryland State Highway Administration (MDSHA) (**Table 3.1**).

Table 3.1 Spray on rejuvenator specifications from different agencies.

Agency	Federal Aviation Administration (FAA)	Florida Pavement Preservation Council (FPPC)	Maryland State Highway Administration (MDSHA)
Spec	P-632	335	2.08.03.03, 2.09.04, 9.01.01.02

Links to each specification are as follows.

- [Federal Aviation Administration \(FAA\) - P-632 Asphalt Pavement Rejuvenation](#)
- [Florida Pavement Preservation Council \(FPPC\) - FPPC335 Asphalt Rejuvenation Specifications](#)
- [Maryland State Highway Administration \(MDSHA\) - 2018 Pavement & Geotechnical Design Guide](#)

3.1 MATERIAL TYPE AND PERFORMANCE

3.1.1 Material Type

The FPPC and the MDSHA specify material description of spray on rejuvenators as shown in **Table 3.2**.

Table 3.2 Material description of spray on rejuvenators.

Agency	FPPC	MDSHA
Spec	335-2	9.01.01.02
Material Description	Emulsion composed of petroleum resin oil base uniformly emulsified with water	Type B-2 with specialized emulsion of maltenes (2 parts maltene + 1 part water)

3.1.2 Recovered Binder Properties

The FAA specifies the rejuvenators must fulfill the following criteria as shown in **Table 3.3** for recovered binders as included in 632-2.1.

Table 3.3 Recovered binder requirements as specified by the FAA (Source: FAA, 2018).

Property of Binder	Requirement for Asphalt Pavement Three Years or Less in Age	Requirement for Asphalt Pavement More Than Three Years in Age	Test Method
Absolute Viscosity $_{60^{\circ}\text{C}}$ (P)	$\geq 25\%$ Decrease	$\geq 40\%$ Decrease	ASTM D2171
Complex Modulus $_{60^{\circ}\text{C}}$, G^* (kPa)			AASHTO T315
Viscosity $_{60^{\circ}\text{C}}$, $\eta = G^*/\omega$ (Pa·s)			
Phase angle $_{60^{\circ}\text{C}}$, δ (°)	Report		

The binder extracted per ASTM 2171, Method A and recovered per ASTM D1856 or D5404 from samples of the upper 3/8-inch of the surface of the treated pavement must exhibit the percent decrease in absolute viscosity or complex viscosity and corresponding phase angle increase listed in **Table 3.3**, when compared to the values from adjacent untreated samples from the same pavement in the prescribed

timeframe. Binder extraction, recovering and testing must be performed within 48 hours of obtaining pavement cores or equivalent surface area samples.

The FPPC specifies that the “asphalt rejuvenating agent shall have the capability to penetrate the asphalt pavement surface, and shall be absorbed and incorporated into the asphalt binder.” Specification 335-3 is summarized in **Table 3.4**.

Table 3.4 Material performance requirements as specified by the FPPC.

Performance	Requirement
Viscosity	Reduced by a minimum of 25% for a pavement two years or less in age, and reduced by a minimum of 40% for a pavement greater than two years in age
Test Method	AASHTO T315-05 Dynamic Shear Rheometer (DSR) method for asphalt testing
Core Requirement	Apply to extracted asphalt binder, taken from cores extracted fifteen to thirty days following application, in the upper 3/8 inch of pavement
Additional Performance Requirement	Treated areas shall be sealed in-depth to the intrusion of air and water

3.1.3 Friction Requirements

The FAA P632-2.2 specifies that the results of the two tests between 24 and 96 hours after application shall indicate friction is increasing at a rate to obtain similar friction value of the pavement surface prior to application. The long-term test shall indicate no apparent adverse effect with time relative to friction values and existing pavement surface.

3.2 ROADWAY CANDIDATE

The FAA states that a typical asphalt pavement candidate must not have structural, load related distresses (or has provisions to correct these distresses) and with low to moderate environmental, temperature related distresses. The recommended corrected Pavement Condition Index in accordance with ASTM D5340 should be equal to or greater than 70 to qualify as a candidate.

The MDSHA Specification 2.08.03.03 specifies the application of asphalt rejuvenator type B-2 is only allowed on roadways fulfilling the criteria as shown in **Table 3.5**.

Table 3.5 Roadway candidate for rejuvenator Type B-2 as specified by the MDSHA.

Criteria	Range
International Roughness Index (IRI)	0 – 100
Average Daily Traffic (ADT)	0 – 25,000
Skid number	Greater than 40
Structural Cracking Index (SCI)	Greater than 75

3.3 GENERAL CONSTRUCTION REQUIREMENTS

3.3.1 Weather and Seasonal Limitations

Rejuvenators must be applied only when the surface is dry. The FAA Specification P632-4.2 states that the rejuvenation product must be applied when the weather forecast is in accordance with the manufacturer's recommendations for application and curing. The FPPC Specification states that the surface treatment shall not be applied when the temperature is less than 40° in the shade. When applying emulsions, the temperature of the surface shall be a minimum of 59°F, and no more than 140°F.

3.3.2 Equipment

The FAA (P632-4.3) and the FPPC (355-4) specifications state that the Contractor must furnish equipment and hardware necessary for the performance of the work. The distributor must be designed and equipped in accordance with the manufacturer's recommendations and capable of delivering the rejuvenators uniformly.

3.3.3 Preparation of Surface

The FAA (P632-4.4) and the FPPC (335-5) call for cleaning pavement surface immediately prior to placing the surface treatment.

3.4 BASIS OF PAYMENTS

The FAA Specification P632-8.1 states that the payment for accepted rejuvenation product will be made at the contract unit price per square yard for asphalt rejuvenation adjusted according to **Table 3.6**.

Table 3.6 Rejuvenation pay reduction as specified by the FAA (Source: FAA, 2018).

Binder Rejuvenation at Acceptance Percent Reduction in Absolute Viscosity or Complex Modulus		% Payment
Pavement More Than 3 Years in Age	Pavement 3 Years or Less in Age	
≥ 40	≥ 25	100
30.0 – 39.9	20.0 – 24.9	75
Less than 30.0	Less than 20.0	No payment

The FPPC Specification 335-8 states that the payment will be made under:

Asphalt rejuvenating emulsion	Per square yard
Test core removal	Each
Test core laboratory analysis – viscosity	Each

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