Arizona Chapter AGC Pavement Preservation Series

Micro Surface and Slurry Seal Guide for Application and Construction

Presented by the Pavement Preservation Committee through the Arizona Chapter Associated General Contractors

Developed by the

Pavement Preservation Committee
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Forward

The Arizona AGC Pavement Preservation guides are collections of best practices and recommendations for the state of Arizona. Microsurfacing and Slurry Seals are important pavement preservation tools, and when constructed properly they increase the life of a pavement. Following these guidelines and using a reputable AGC member contractor will also contribute to the overall success of the project.

There will be instances where conditions or materials dictate the need to deviate from these guides. It is important that contractors, suppliers, and agencies work together and use common sense to modify these recommendations as needed.

The Arizona Chapter of the Associated General Contractor's Pavement Preservation committee developed this guideline to identify “best practices” to be used during the application of microsurfacing and slurry seals.

The committee is comprised of contractors, material suppliers, aggregate producers and agency personnel. Special thanks to our partners in the Arizona Department of Transportation: Bill Hurguy, State Materials Engineer, and Janet Doerstling Pavement Materials Testing Manager for their contributions.

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Introduction

This document is provided as a guide for suppliers, contractors, agencies and owners.

Microsurfacing and Slurry seals are cost effective preservation treatments used to maintain and extend the service life of pavements and roadways. These applications extend the life of pavements by preventing moisture intrusion into the base course and sub-grade. Additional benefits include increased skid resistance and improved aesthetics. When properly constructed, microsurfacing and slurry seal applications are cost effective tools that provide improved life cycle benefits.

Although microsurfacing and slurry seals are generally similar, microsurfacing is designed to facilitate a quicker return to traffic, heavier application rate, rut filling, and support higher traffic volumes.

This guide contains best practice information to improve consistency. Many variables affect the successful application of microsurfacing and slurry seals. These variables will be discussed in more detail:

- Existing Surface Conditions
- Surface Preparation
- Materials
- Equipment
- Placement Practices
- Construction Procedures

2 - Surface Conditions and Preparation

2.1 Surface Conditions

2.1.1 Surface Conditions – need to describe suitable conditions that these applications will address.

2.1.2 Surface Condition Limitations – need to describe conditions where these products are not suitable.

2.1.3 Need to discuss conditions where microsurfacing would have an advantage over slurry seals.

2.2 Preparation

2.2.1 Significant deficiencies in the pavement surface should be repaired before applying microsurfacing and slurry seals.

2.2.2 Unlike slurry, microsurfacing material may be used to fill ruts and depressions in the surface. Ruts of ½" or greater in depth shall be filled with a rut-filling box. Ruts deeper than 1" may require multiple lifts of micro surfacing material.

2.2.3 Cracks ¼ inch or wider should be filled. Crack filler overbands on the pavement surface should not exceed 4 inches wide and ⅛of an inch thick.

2.2.4 Pavement edge deterioration should also be repaired.

2.2.5 The type of material used for the various repairs is important and can affect the quality and overall longevity of the finished surface. Patching and crack seal materials should be given time to cure before placing a microsurfacing or slurry seal (refer to manufacturer's recommendations).

3.0 - Materials

3.1 All materials shall be approved by the Engineer prior to the start of construction. The following shall be used to estimate the quantities of emulsion asphalt and dry mineral aggregate for microsurfacing and slurry seals. Exact quantities of additive, emulsion, mineral filler, and aggregate shall be determined by the mix design, or as directed by the engineer.

3.2 Aggregate

3.2.1 For high performance microsurfacing and slurry seals, quality aggregate is mandatory. Some of the key indicators of quality aggregate are: proper gradation, particle shape, cleanliness, soundness, and resistance to abrasion.

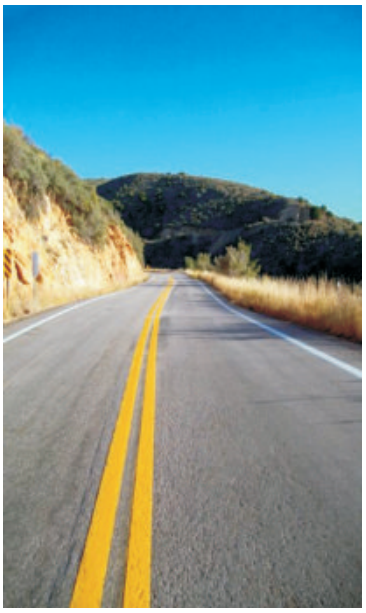
3.2.2 Aggregates used in microsurfacing and slurry systems come in three standard gradations, each with a designated use:

3.2.2.1 Type I aggregate (the smallest size gradation). It is primarily used to address minor surface defects such as surface voids and cracks. It is also used when protection from the elements is the main reason for resurfacing. Type I aggregates are commonly used for airfields and parking lots.

3.2.2.2 Type II aggregate is used to fill surface voids and correct moderate surface defects. It is typically used on pavements with medium-textured surfaces that require correction of weathering and raveling, while producing an adequate wearing surface for medium to heavy traffic.

3.2.2.3 Type III aggregate (the largest gradation) is used to improve friction, and skid resistance. Durability is also improved due to increased mat thickness. It is best-suited for higher-traffic pavements such as collectors, arterials and major highways. When Type III aggregates are used in microsurfacing, stability is also increased, making the gradation ideal for rut filling and reestablishing profiles with minor surface irregularities.

Existing pavement condition prior to Type III slurry.



Type III slurry application

Table 1- ISSA A143 Gradations

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing Sieve Size
3/8" (9.5 mm)	100	100	100
#4 (4.75 mm)	100	90-100	70-90
#8 (2.36 nun)	90-100	65-90	45-70
#16 (1.18 mm)	65-90	45-70	28-50
#30 (600 um)	40-65	30-50	19-34
#50 (330 um)	25-42	18-30	12-25
#100 (150)	15-30	10-21	7-18
#200 (75)	10-20	5-15	

3.3 Aggregate Considerations

3.3.1 Aggregate material should be blended appropriately and the loader should work evenly across the face of the entire stockpile.

3.3.2 The aggregate shall be free from surface water at the time of application.

3.3.3 It is important to utilize an aggregate composed of clean and durable crushed rock. All aggregate should be processed to meet the gradation and physical property requirements.

Test	Method	Slurry Specification	Microsurfacing Specification
Sand Equivalent Value of Soils and Fine Aggregate	AASHTO T 176	50 Minimum	60 Minimum
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	AASHTO T 104	15% Maximum w/NA2SO4 25% Maximum w/MgSO4	15% Maximum w/NA2SO4 25% Maximum w/MgSO4
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	AASHTO T 104	15% Maximum w/NA2SO4 25% Maximum w/MgSO4	15% Maximum w/NA2SO4 25% Maximum w/MgSO4
Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine1	AASHTO T 96	35 % Maximum	30% Maximum

1 The abrasion test is run on the parent aggregate.

3.4 Emulsions

3.4.1 There are numerous types of emulsions utilized in microsurfacing and slurry seals. Emulsions are an important part of microsurfacing and slurry seals because they affect the speed of set, time to return to traffic, and improve performance characteristics of the finished product. ADOT's emulsion specifications are included and recommended for slurry seal and microsurfacing emulsions .

3.4.2 The following tables show ADOT's slurry seal coat emulsion specification #404h

Test on Emulsions

Properties	Test Method	Non-Polymer Modified	Polymer Modified
Viscosity, 77°F, SFS	AASHTO T-59	20-100	20-100
Residue by Evaporation, %	Arizona Test Method 512	57 Min	57 Min
Sieve Test, #20, %	AASHTO T-59	0.10 Max	0.10 Max
Particle Charge, Electroplate	AASHTO T-59	Negative or Positive	Negative or Positive

Test on Residue

For non-polymer modified emulsion, the residue shall be obtained in accordance with Arizona Test Method 504. For polymer modified emulsion, the residue shall be obtained by distillation in accordance with AASHTO T-59 (350° F maximum).

Properties	Test Method	Non-Polymer Modified	Polymer Modified
Penetration 77°F, 100g, 5 seconds, dmm	AASHTO T-49	40-110	40-110
Ductility 77°F, cm	AASHTO T-51	40 Min	40Min
Polymer Content (weight)	California Method 401		4% Min
Absolute Viscosity 140°F, poise	AASHTO T-202		2,000 Min
Penetration, 39.2oF, 200g, 60 seconds, dmm	AASHTO T-40		20 Min

3.4.2 The following tables shadow ADOT'S microsurfacing emulsion specification Item #401. In addition to the individual characteristics of each emulsion type, they each have a unique handling requirement. Emulsions should be stored so that they do not freeze or sit stagnant for extended periods of time. For all emulsion types, the contractor should follow the supplier's handling procedures and recommendations.

Tests on Emulsion		
Viscosity, 77°F, SFS	AASHTO T-59	75-100
Sieve Test, %	AASHTO T-59	0.30 Max
Particle Charge	AASHTO T-59	Positive
Storage Stability* Test, 24 hours, %	AASHTO T-59	1.0 Max
Evaporation Residue, %	Arizona Test Method 512	60 Min
Tests on Residue by Distillation	AASHTO T-59 (350°F Max)	
Kinematic Viscosity, °275F, cst	AASHTO T-201	650 Min
Penetration, 77°F 100g, 5 seconds, dmm	AASHTO T-49	40-90
Softening Point, degrees F	AASHTO T-53	140 Min
Ductility, 77°F, 5 cm/min	AASHTO T-51	60 Min
Tests on Distillation Residue after RTFO		
Kinematic Viscosity, °275F, cst, aging ratio	AASHTO T-201	2.5 Max
Softening Point, degrees F	AASHTO T-53	140 Min

4 - Mix Design

4.1 Mix designs should be conducted by experienced laboratories only. ADOT specifications required slurry and microsurfacing designs to be signed by a licensed professional engineer in the state of Arizona.

4.2 .Before work begins, the contractor shall submit a mix design to the agency. When specified, the mix design shall be signed by a professional engineer licensed in the state of Arizona.

.4.3 Mix Designs shall meet the following requirements:

Test	ISSA TB No.	Slurry Spec	Microsurfacing Spec
Mix Time @77°F(25°C)	TB 113	180 Seconds Min	120 Seconds Min
Slurry Seal Consistency	TB 106	0.79-1.18 inches	
Wet Cohesion @ 30 Minute Minimum (Set) @ 60 Minute Minimum (Traffic)	TB 139	 12 kg-cm Min 20 kg-cm or Near Spin Min	 12 kg-cm Min 20 kg-cm or Near Spin Min
Wet Stripping	TB 114	Pass (90% Min)	Pass (90% Min)
Wet-Track Abrasion Loss One Hour Soak Six Day Soak	TB 100	75 g/ft^2 (807g/m^2) Max	50 g/ft^2 (807g/m^2) Max 75 g/ft^2 (538 g/m^2) Max
Excess Asphalt by LWT Adhesion	TB 109	50 g/ft^2 (538g/m^2) Max	50 g/ft^2 (538g/m^2) Max
Lateral Displacement	TB 147		5 % Max
Specific Gravity after 1,000 Cycles of 125 lb (56.71 kg)			2.10 Max
Classification Compatibility	TB 144		11 Grade Points Minimum (AAA, BAA)

5 - Equipment

5.1 Mixer

The slurry seal mixer shall be a continuous flow-mixing unit. It shall be capable of accurately proportioning and delivering aggregate, emulsified asphalt, mineral filler, water, and other additives to the pugmill (mixing chamber). It shall discharge the thoroughly mixed product continuously.

5.1.2 The sequence of addition shall be: aggregate, water, additives, mineral filler, and then emulsion. The mixer shall be capable of blending the ingredients together. Mixing shall be performed in a manner to prevent foaming.

5.1.3 The mixing unit shall be equipped with a fines feeder that provides an accurate metering device or method to control the amount of mineral filler added.

5.1.4 Additives may be used to accelerate or retard the set time of the application. These additives should be detailed on the mix design or approved by the engineer. The additive pump must be a controlled metered device that accurately delivers additive to the mixing chamber.

5.2 Spreading Equipment
Attached to the mixer shall be a mechanical type squeegee distributor (sled).

5.2.1 The sled must be equipped with a flexible rubber material. This material should be kept in contact with the existing surface and shall otherwise maintain the spreader box to prevent loss of material on varying grades and crowns by adjustments to ensure uniform spread.

5.2.2 The spreader box shall be equipped with a canvas or burlap drag to provide a rough surface texture. The drag shall be replaced as needed.

4.3 Calibration

Each mixing unit shall be calibrated at least once per year for each aggregate source and type, or as required by the agency. The calibration shall include a metered verification for each material used. No machine should be allowed to work on the project until the calibration has been completed and/or accepted.

4.3.1 Equipment Calibration Procedure for positive displacement pumps

4.3.2 Connect the production emulsion pump output to a container.

4.3.3 Run the pump long enough to fill the connection hose with emulsion to ensure all runs are the same.

4.3.4 Zero the counter before each run.

4.3.5 Pump a large enough sample of emulsion on each of three runs to ensure the accuracy will be 2% or better. The sample size is calculated by dividing the accuracy of the scale of 2% (0.02).

For example, if weighing the emulsion sample in a barrel on a platform scale with an accuracy of + 1 pound, the minimum sample needs to be 50 pounds (1lb/0.02).
Determine the net weight for each run by weighing either the placement machine (or a truck scale) before and after the run or weighing the emulsion pumped (on a platform scale). Divide the net weight pumped by the number of counts of the rock/aggregate belt for the three test samples and record the pounds per count for each.

4.3.6 Average the pounds per count for the three runs.

4.3.7 The placement machine should deliver such volumetric consistency that the deviation for any individual emulsion run shall not exceed 2 percent of the mathematical average of three runs.

4.3.8 The average pounds per count results will be used in the gate setting calculations.

4.3.9 Equipment calibration procedure for variable displacement pumps

4.3.10 Set the emulsion pump to the factory recommended setting and lock in place.

4.3.11 Follow the positive displacement pump procedure.

4.3.12 If the gate setting for the aggregate is unusually high, decrease the emulsion pump volume setting and perform the calibration again.

4.3.13 The gate setting for the aggregate is unusually low, increase the emulsion pump volume setting and perform the calibration again.

5 - Placement Practices

5.1 A microsurfacing and slurry seal mix design procedure should be utilized to establish targets for emulsion, aggregate, mineral filler and additive application rates. (See design sample, Appendix A.)

Considerations for slurry application rate are as follows:

- Aggregate gradation and quality
- Type of emulsion
- Existing roadway conditions (deterioration and porosity of the roadway)
- Maintenance efforts and timing of those efforts prior to application
- Traffic conditions (present and future volume and percentage of truck traffic)
- Weather and environmental conditions

5.2 The mix design should be followed within the tolerances established. Deviations may be required based on circumstance and should be approved through the engineer.

6 - Construction Procedures

6.1 General Considerations

Prior to the application, the existing surface must be cleaned of all foreign materials. Cleaning may require the use of mechanical sweepers or brooms.

6..2 Once the surface has been prepared, application can occur. Microsurfacing and Slurry seals should be applied when the surface temperature is 45° F and rising. (Surface temperature should be measured prior to the start of operations).

6.3 Slurry seal should not be performed if wind speeds are greater than 30 mph or rain is imminent.

6.4 Rolling

Rolling is not typically needed or required for microsurfacing and slurry seal applications. If rolling is specified, roller type should be chosen to match the specification or at the discretion of the engineer.

6.4.1 The rollers should carry a minimum loading of 2,000 pounds on each wheel, with a minimum tire pressure of 90 psi or as recommended by the equipment manufacturer.

6.5 Sweeping

Sweeping with a mechanical broom and high efficiency vacuum sweepers is the best method to clean the pavement surface. The bristles (broom head) should not be worn, and should be operated in such a manner that removes dust and debris from the roadway.

6.6 Traffic Control

All traffic, with the exception of necessary construction equipment, should be kept off the newly applied microsurface or slurry seal until these materials have had time to properly set. Barricades, signage and traffic control will follow current MUTCD (Manual on Uniform Traffic Control Devices) standards.

7 - Method of Measurement

7.1 Emulsified asphalt will be measured by the ton.

7.2 Mineral aggregate will be measured by the ton, excluding the weight of any moisture.

8 - Summary

The following is a summary of the best practices that should be used to obtain a quality project:

Complete all needed repair work and allow adequate curing time prior to the placement of the application.

Microsurfacing and slurry seals should be applied when the surface temperature is 50° For higher and the ambient temperature is 45°F and rising.

Materials should be tested prior to and during all phases of construction to assure specification compliance.

Use and follow a current mix design for each project.

Check Lists for Proper Slurry Seal Technique
replace with ADOT check list

	YES	NO
1. Is there an approved mix design with the appropriate materials.	☐	☐
2. Is the mix design being followed	☐	☐
3. Does the aggregate meet the specified requirements?	☐	☐
4. Is aggregate stockpiled so that it will not become contaminated?	☐	☐
5. Has the application rate been determined?	☐	☐

Construction Techniques/Application

1. Is traffic control in compliance with approved plan?	☐	☐
2. Have pavement markers been considered?	☐	☐
3. Is the ambient temperature at 45F and rising?		
4. Is the pavement clean and dry?	☐	☐
5. Is there a chance of rain during the daily production?		
6. Has the equipment been calibrated?	☐	☐

Appendix A

Micro-Surfacing Treatment

Component	Proportions	Tolerances
Optimum emulsion content, % (by weight of dry aggregate)	12.0	11.0 - 13.0
Residual asphalt content, % (by weight of dry aggregate at a residue content of 66.3%)	8.0	7.30 - 8.6
Type I Portland Cement, % (by weight of dry aggregate)	0.3	0.1 - 2.0
Aluminum Sulfate, % (by weight of dry aggregate)	0.2	As Required
Mix water, % (by weight of dry aggregate)	9.0	As Required

*Temperature and wind conditions during field applications may vary from controlled laboratory conditions requiring modification of the water content to maintain a smooth, free flowing homogeneous mixture. Only as much additional water as necessary to maintain proper working consistency, without segregation and/or separation, should be used.

RESIDUE BY EVAPORATION (AI 512)

Residue by Evaporation, Average of three points:	66.3%

MICRO SURFACING MIXTURE TESTS (ISSAMelhods)

Parameter	Results	Comments	Specified Limits
Consistency at 2.5cm (ISSA TB-115)	Satisfactory	Pass	2.5 to 3.0 cm
Split Consistency (ISSA TB-115)	Uniform	Pass	No Asphalt or Aggregate Migration
Slurry seal Setting test, 75°-79°F 120 sec.(ISSA TB-102)	Consistent Slurry	Pass	Uniform Aggregate and Dispersion
Slurry seal Setting test, 75°-79°F 60 minute cure (ISSA TB-102)	No Stains	Pass	No Brown Stain
Wet Stripping (TB-114)	100%	Pass	90% Minimum Coating

WET TRACK ABRASION (ISSA T8·100)

Emulsion Content (%)	Mixing Water (%)	Total Fluid (%)	Consistency Test (cm)	Residual AC Content (%)	One Hour Soak		6 Day Soak	
					Abrasion (Grams /sq.ft)	Specification	Abrasion (Grams /sq.ft)	Specification
10	11	21	2.8	6.6	17.4	50 grams/sq ft. Max	17.9	75 grams/sq ft. Max
12	9	21	2.8	8.0	11.8		11.7	
14	7	21	2.8	9.3	9.8		8.9	

SAND ABRASION (ISSA T8·109)

TACK POINT

Cycles	Load (lb)	Temperature (°C)
1000	125	22

SAND ADHESION

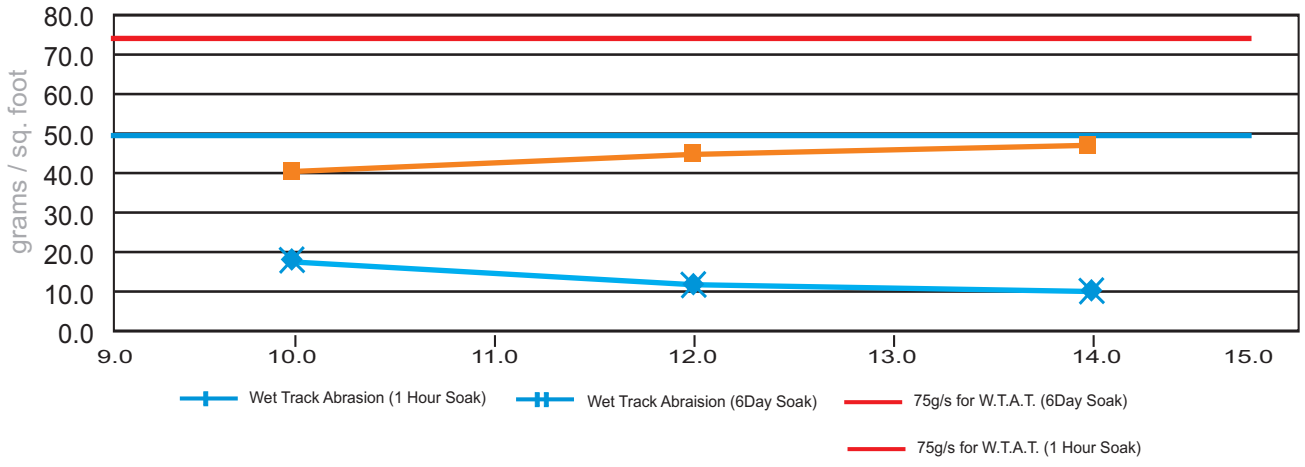
Vehicles/day >3000

Emulsion Content (%)	Cycles	load (lb)	Temperature (°C)	Weight (grams)	Sand Adhesion (grams/sq.ft.)	Specification
10%	100	125	22	5.4	41.5	50 grams/sq.ft. Max
12%	100	125	22	5.8	44.6	
14%	100	125	22	6.1	46.9	

LATERAL DISPLACEMENT AND SPECIFIC GRAVITY AFTER 1000 CYCLES OF 125 1b. (ISSA T8·147)

Emulsion Content (%)	Lateral Displacement ISSA (TB-147)		Specific Gravity ISSA (TB-147)	
(%)	(%)	Specification	Compacted SPGR	Specification
12.0%	1.3%	5.0% Max	1.953	2.10 Max

VARIATION OF WET TRACK ABRASION & SAND ADHESION WITH EMULSION CONTENT



COHESION (ISSA TB-139)

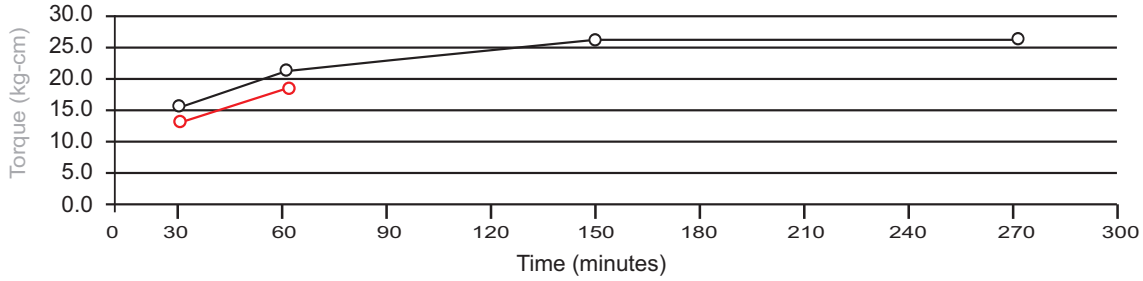
CALIBRATION

20/20 MESH OTTAWA SAND	4.8 KG-CM
-#5/16 MATERIAL	4.8 KG-CM

COHESION DATA

Time (min)	Torque (kg-cm)	Specification, min. (kg-cm)
30	15.0	12
60	22.0	20
90	23.0	–
150	26.0	–
210	26.0	–
270	26.0	–

VARIATION OF TORQUES WITH TIME



AGGREGATE

Sieve Size	% Passing	Mix Design Specs Type III	Production Band
3/8"	100	100	100
#4	81	70-90	76-86
#8	51	45-70	45-56
#16	34	28-50	29-39
#30	25	19-34	20-30
#50	18	12-25	14-22
#100	13	7-18	10-16
#200	9.1	5-15	6.1-12.1

		Mix Design Specification
Sand equivalent (MSHTO T 176)	63	Min 60
Fractured Face (AZ 212)	100%	95% (at least 1-FF)
Uncompacted Void Content (AZ 247)	47.5%	Min 45.0%
Specific Gravity.(ARZ. 211b)	2.593%	–

THEORETICAL BATCH PROPORTIONS

Material	Quantity (lbs)	% by Weight of Dry Aggregate	Tolerances	
			Minimum	Maximum
Type III Micro-Surfacing Aggregate	2000	–	–	–
Type I Portland Cement	6	0.3	0.1	2.0
Optimum Emulsion Content	240	12.0	11.0	13.0
Mixing Water	180	9.0	--	--
Theoretical Asphalt Content	–	8.0	7.3	8.6
Aluminum Sulfate	–	0.2	--	--

Table 1 : SB Test Results (ISSA TB 144)

Test		Result	Requirement
Aggregate #654 + 12.9% Emulsion, 10% Water, 0.5% Cement			
SB,s (TB 144	- Points	12	11 Min (12 possible)
	- Absorption	1.73g	no spec
	- Abrasion	0.53g	0-0.7g = 4 points
	- Integrity	98.32%	90-100 = 4 points
	- Ruck Adhesion	99%	>90 = 4 points
Aggrgate #654 + 12.9% Emulsion, 10% Water, 0.5% cement. 0.1% Sulfate (38%)			
SB's (TB 144)	- Points	12	11 Min (12 possible)
	- Absorption	1.4g	no spec
	- Abrasion	0.45g	0-0.7g = 4 points
	- Integrity	98.54%	90-100 = 4 points
	- Ruck Adhesion	98%	>90 = 4 points
Aggrgate #654 + 12.9% Emulsion, 10% Water, 1.0% cement. 0.1% Sulfate (38%)			
SB's (TB 144)	- Points	12	11 Min (12 possible)
	- Absorption	1.19g	no spec
	- Abrasion	0.65g	0-0.7g = 4 points
	- Integrity	98.02%	90-100 = 4 points
	- Ruck Adhesion	98%	>90 = 4 points

ASPHALT CLASSIFICATION SUMMARY

AMEC Lab No.:	1239827
Grade:	PMCQS-1h
Tank No.:	C-4
Sample ID:	np
Date Received:	05-07-2012
Sample Date:	05-07-2012
Sample Type:	Concentrate

Tests on Emulsion	**Test Method**	**Spec**	
Saybolt Furol Viscosity, (77°F), s	AASHTO T59	20-100	50
Sieve Test, %	AASHTO T59	0.10 max	0.00
Particle Charge	ASHTO 159	Positive	Positive
Storage Stability, 24 hrs, %	AASHTOT59	1.0 max.	0.12
Residue by Evaporation, %	ARIZ 512	60 min.	66.3
Tests on Residue from Distillation to 350°F	AASHTO T59		
Kinematic Viscosity, 275°F cSt	AASHTO T201	650 min.	4,378
Penetration, (77°F), 100o, 5s dmm	AASHTO T49	40 - 90	64
Softenina Point of °F	AASHTO T53	140 min.	147
Ductilitv, 177°F), 5cm/min cm	AASHTQ 151	60 min.	150+
Elastic Recovery, (77°F), %	AASHTO T301	55 min.	80

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