Engineering Brief # 46A Chg. 1

Date: April 4, 1996

ENGINEERING BRIEF NO. 46A Chg. 1

COAL-TAR PITCH EMULSION SEAL COAT

From: Acting Manager, Engineering and Specifications Division, AAS-200
To: All Regions

Attn: Manager, Airports Division

Attached is a copy of Engineering Brief (EB) No. 46A, CHANGE 1. This change incorporates updated information on high sand loading rubberized coal-tar emulsion slurry seals. The principal changes are to P-628, Rubberized Coal-Tar Pitch Emulsion Slurry Seal, and Appendix A to P-628.

1. A single gradation is specified and the gradation table in paragraph 628-2.1 has been modified to delete sieve No. 50 from the gradation and add sieve No. 100.

2. The requirements for latex rubber in paragraph 628-2.4 have been modified to place limitations on particle size, butadiene type, and add requirements for silicones.

3. The capabilities of the distributors or spray units in paragraph 628-4.2(a) have been modified to widen application rates.

4. The experience requirements of the consultant in paragraph 628-5.2 have been revised to require experience in the use of rubberized coal-tar seal coats using 16-20 pounds of aggregate per gallon of emulsion.

5. The second coat of composite seal coat has been removed from the fuel resistance test in Appendix A, Step 6.

Please replace P-628 and Appendix A to P-628 with this Change and advise this office of any problems encountered in the laboratory or field while using the revised specifications.

Sincerely,
ORIGINAL SIGNED BY
John L. Rice

ENGINEERING BRIEF NO. 46A CHANGE 1

ITEM P-628 RUBBERIZED COAL-TAR EMULSION SLURRY SEAL

DESCRIPTION

628-1.1 This item shall consist of an application of a coal-tar emulsion slurry seal with or without mineral aggregate, and with the use of a latex rubber applied on an existing, previously prepared bituminous surface, in accordance with these specifications for the area shown on the plans or as designated by the Engineer. The material is intended for use as a fuel resistant sealer and to even out small irregularities in the pavement.

MATERIALS

628-2.1 AGGREGATE. The aggregate shall either be a natural or manufactured angular aggregate and shall be composed of clean, hard, durable, uncoated particles, free from lumps of clay and all organic matter. The aggregate shall meet the gradations in Table 1, when tested in accordance with ASTM C 136.

TABLE 1. GRADATION OF AGGREGATES

Sieve size	Percentage By Weight Passing Sieves
No. 8 (2.36 mm)	100
No. 16 (1.18 mm)	97-100
No. 20 (0.85 mm)	85-100
No. 30 (0.60 mm)	15-85
No. 40 (0.40 mm)	2-15
No. 100 (0.15 mm)	0-2

628-2.2 BITUMINOUS MATERIALS. The bituminous material shall be a coal-tar emulsion prepared from a high temperature, coal-tar pitch conforming to the requirements of ASTM D 490, grade 11/12. Oil and water gas tar shall not be used even though they comply with ASTM D 490. The coal-tar emulsion shall conform to all requirements of Federal Specification R-P-355 except that the water content shall not exceed 50 percent.

628-2.3 WATER. The water used in mixing shall be potable and free from harmful soluble salts. The temperature of the water added during mixing shall be at least 50 degrees F (10 degrees C). The pH of the water added during mixing shall conform to the requirements of the coal tar emulsion manufacturer.

628-2.4 LATEX RUBBER. The rubber shall be a copolymer latex containing 51-70 parts butadiene and 30-49 parts acrylonitrile with a minimum solids content of 40 percent with a particle size less than 80 nanometers and silicones at 4 percent of the rubber content. The rubber shall be compatible with the coal-tar emulsion used by the Contractor and must mix homogeneously with the coal-tar emulsion, water, and aggregate in the proportions specified to produce a mixture that will adequately suspend the aggregate during mixing and application.

COMPOSITION AND APPLICATION

628-3.1 COMPOSITION. The rubberized coal-tar emulsion slurry seal shall consist of a mixture of coal-tar emulsion, water, latex rubber, and aggregate in proportions that fall within the ranges shown in Table 2.

628-3.2 JOB MIX FORMULA. For a rubberized sand slurry, the Contractor shall submit a job mix formula and application rate to atesting laboratory together with sufficient materials to verify the formulation. The laboratory shall verify the proportions of emulsion, water, aggregate and rubber using the mix design procedures contained in Appendix A. The mix design shall be within the range shown in Table 2 and meet the requirements of Table 3. A copy of the mix design and test data shall be submitted to the Engineer at least [ ] days prior to the start of operations and shall include as a minimum:

a. Water (gal/gal of emulsion)
b. Aggregate (lbs/gal of emulsion) c. Rubber (gal/gal of emulsion) d. Viscosity of total liquids
e. Viscosity of composite mix
f. pH of water
g. Mixing sequence of materials
h. scuff resistance, freeze-thaw, adhesion, and fuel resistance.

No slurry seal shall be produced for payment until the job mix formula has been approved by the Engineer.

Rubberized coal-tar emulsion slurry seal formulations are sensitive to the characteristics of individual latex additives. Not all products will provide satisfactory seal coat formulations for all combinations of coal tar emulsion, water, and rubber additive.

Water used in the job mix design should be obtained from the source the Contractor proposes to use in the field.

The job mix formula for each mixture shall be in effect until modified in writing by the Engineer.

* *

Improper formulations of rubberized coal-tar emulsion slurry seal produce coatings that crack prematurely or do not adhere properly to the pavement surface.

A minimum of 5 days is recommended for job mix approval.

The quantity of materials (aggregate and rubber) and the application rate (with a ñ tolerance) shall be specified by the Engineer, within the ranges shown in this note. These quantities and the application rate are a function of the degree of pavement oxidation. The composition shall be inserted into Table 2. Asterisks denote insert points.

COMPOSITION OF MIXTURE

Type of Slurry Seal	Composition and Quantities: Water gal./gal. of emul.	Aggregate lbs/gal. of emul.	Rubber gal./gal. of emul.	Application Rate gal./sq.yd. (per application)
Rubberized Sand slurry	0.80(max)	16-20	0.10-0.14	0.35-0.55
Rubberized Emulsion	0.80(max)	-	0.03-0.05	0.20-0.25

* *

* TABLE 2. COMPOSITION OF MIXTURE

Type of Slurry Seal	Composition and Quantities: Water gal./gal. of emul.	Aggregate lbs/gal. of emul.	Rubber gal./gal. of emul.	Application Rate gal./sq.yd. (per application)
Rubberized Sand slurry	*	*	*	*
Rubberized Emulsion	*	*	*	*

TABLE 3 DESIGN CRITERIA

Test Property	Purpose	Criterion
Brookfield Viscosity poises @ 77F	Incompatibility between latex and coal tar	10-90
Brookfield Viscosity poises @ 77F	Workability of composite mix	10-90
Scuff Resistance lbs torque @ 8 hours	Rate of set	>100 in-
Scuff Resistance torque torque @ 24 hours	Final scuff	>8 hr
Freeze-Thaw	Cracking	
@ 5 cycles		< 1
@ 10 cycles		< 3
Adhesion	Loss of adhesion	Rating = 5A
Fuel Resistance	Fuel penetration	No

penetration
Loss of adhesion or loss of
adhesion

628-3.3 APPLICATION RATE. Two coats of rubberized sand slurry shall be applied. A final coat of rubberized emulsion shall be applied. The application rates submitted with the job mix formula shall be verified during placement of the test section and shall fall within the limits shown in Table 2.

628-3.4 TEST SECTION. Prior to full production, the Contractor shall prepare a quantity of mixture in the proportions shown in the approved mix design. The amount of mixture shall be sufficient to place a test section a minimum of 250 square yards at the rate specified in the job mix formula. The area to be tested will be designated by the Engineer and will be located on a representative section of the pavement to be slurry sealed . The actual application rate will be determined by the Engineer during placement of the test section and will depend on the condition of the pavement surface.

The test section shall be used to verify the adequacy of the mix design and the application rate. The same equipment and method of operations shall be used on the test section as will be used on the remainder of the work.

Two viscosity tests each shall be made on the total liquids and the composite mix. The average viscosity shall be within ñ 15 poises of the job mix viscosity determined in paragraph 628-3.2. Test results shall be available within 2 days.

If the test section should prove to be unsatisfactory, the necessary adjustments to the mix composition, application rate, placement operations, and equipment shall be made. Additional test sections shall be placed and evaluated, if required. Full production shall not begin without the Engineer's approval. Acceptable test sections shall be paid for in accordance with paragraph 628-7.1.

* *

The test section affords the Contractor and the Engineer an opportunity to determine the quality of the mixture in place as well as the performance of the equipment. The application rate depends on the surface texture. If operational conditions preclude placement of a test section on the pavement to be sealed, it may be applied on a pavement with similar surface texture.

* *

CONSTRUCTION METHODS

628-4.1 WEATHER LIMITATIONS. The seal coat shall not be applied when the surface is wet or when the humidity or impending weather conditions will not allow proper curing. The seal coat shall be applied only when the atmospheric or pavement temperature is 50 degrees F (10 degrees C) and rising and is expected to remain above 50 degrees F (10 degrees C) for 24 hours, unless otherwise directed by the Engineer.

628-4.2 EQUIPMENT AND TOOLS. The Contractor shall furnish all equipment, tools, and machinery necessary for the performance of the work.

a. Distributors. Distributors or spray units used for the spray application of the seal coat shall be self-propelled and capable of uniformly applying 0.05 to 0.55 gallons per square yard (0.23 to 2.5 liters per square meter) of material over the required width of application. Distributors shall be equipped with removable manhole covers, tachometers, pressure gauges, and volume-measuring devices.

The mix tank shall have a mechanically powered, full-sweep, mixer with sufficient power to move and homogeneously mix the entire contents of the tank.

The distributor shall be equipped with a positive displacement pump so that a constant pressure can be maintained on the mixture to the spray nozzles.

b. Mixing Equipment. The mixing machine shall have a continuous flow mixing unit capable of accurately delivering a predetermined proportion of aggregate, water, emulsion and rubber, and of discharging the thoroughly mixed product on a continuous basis. The mixing unit shall be capable of thoroughly blending all ingredients together and discharging the material to the spreader box without segregation.

c. Spreading Equipment. Attached to the mixing machine shall be a mechanical-type squeegee distributor, equipped with flexible material in contact with the surface to prevent loss of slurry from the spreader box. It shall be maintained to prevent loss of slurry on varying grades and adjusted to assure uniform spread. There shall be a lateral control device and a flexible strike-off capable of being adjusted to lay the slurry at the specified rate of application. The spreader box shall have an adjustable width. The box shall be kept clean; coal-tar emulsion and aggregate build-up on the box shall not be permitted.

d. Calibration. The Contractor shall furnish all equipment and materials and labor necessary to calibrate the equipment. It shall be calibrated to assure that it will produce and apply a mix that conforms to the job mix design. Commercial equipment should be provided with a method of calibration by the manufacturer. All calibrations shall be made with the approved job materials prior to applying the seal coat to the pavement. A copy of the calibration test results shall be furnished to the Engineer.

628-4.3 PREPARATION OF PAVEMENT SURFACE. Bituminous pavement surfaces which have been softened by petroleum derivatives or have failed due to any shall be removed to the full depth of the damage and replaced with new bituminous concrete similar to that of the existing pavement. Areas of the pavement surface to be treated shall be in a firm consolidated condition. They shall be sufficiently cured so that there is no concentration of oils on the surface.

A period of [ ] days shall elapse between the placement of a bituminous surface course and the application of the seal coat.

* *

The engineer shall specify the time period. In order to ensure adequate adhesion and minimize cracking and curling, the pavement surface must be sufficiently cured prior to applying the seal coat. Experience has shown that approximately 90 days of hot weather (daytime temperatures or 70 degrees F) is needed for adequate curing.

One means of determining if the pavement has cured adequately is to pour a cup of water on the pavement surface and observe if any oils appear in the standing water. If oils appear, the surface is not sufficiently cured to accept a seal coat.

* *
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628-4.4 CLEANING EXISTING SURFACE. Prior to placing the seal coat, the surface of the pavement shall be clean and free from dust, dirt, or other loose foreign matter, grease, oil, or any type of objectionable surface film. When directed by the Engineer, the existing surface shall be cleaned with wire brushes and a power blower.

Where vegetation exists in cracks, the vegetation shall be removed and the cracks cleaned to depth of two inches where practical. Those cracks shall be treated with a concentrated solution of a herbicide approved by the Engineer. Cracks shall then be [ ]. Areas that have been subjected to fuel or oil spillage shall be wire brushed to remove any dirt accumulations. The area shall then be primed with shellac or a synthetic resin to prevent the seal coat from debonding.

* *

* The Engineer shall specify the appropriate method of treating cracks depending on the frequency and severity. This may include routing, milling, etc. and filling with the rubberized emulsion seal slurry.

* *
*

628-4.5 TACK COAT. A tack coat shall be applied only if recommended by the emulsion supplier. After the surface has been prepared, a tack coat of 3 parts water to 1 part emulsified binder, as specified in paragraph 628-2.2, shall be applied at the rate of 0.05 to 0.10 gal/sy of surface.

When a tack coat is not specified the pavement shall be dampened with a fog spray of water if recommended by the supplier. No standing water shall remain on the surface.

Following the application, the surface shall be allowed to cure without being disturbed for such period of time as may be necessary to permit adhesion of the seal coat. This period shall be determined by the Engineer. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval.

628-4.6 APPLICATION OF RUBBERIZED SAND SLURRY. The rubberized sand slurry shall be applied at a uniform rate with a distributor or squeegee at the rate determined in paragraph 628-3.4. When the emulsion, water, aggregate, and rubber are blended, the material shall be premixed to produce a homogeneous mixture of uniform consistency. The quantities of materials to be combined in each batch shall be in accordance with the approved mix design.

The mixing sequence of the various components shall be the same as indicated in the job mix formula. After all constituents are in the mixer, the mixing shall continue for approximately five minutes or longer, if necessary. The mixing shall produce a smooth, free flowing homogeneous mixture of uniform consistency. Slow mixing shall be continuous from the time the emulsion is placed into the mixer until the slurry is applied by distributor truck or poured into the spreading equipment. During the entire mixing process, no breaking, segregating, or hardening of the emulsion nor balling, lumping, or swelling of the aggregate shall be permitted. The slurry shall be applied at a uniform rate to provide the quantity determined during placement of the test strip.

When a spreader box is used, a sufficient amount of slurry shall be fed in the spreader box to keep a full supply against the full width of the squeegee, so that complete coverage of all surface voids and cracks is obtained.

Manufacturer's recommendations regarding application by spraying or squeegeeing should be followed. In areas inaccessible to equipment, the slurry may be applied by means of a hand squeegee. Upon completion of the work, the seal coat shall have no pin holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement. The finished surface shall present a uniform texture.

Each application shall be allowed to dry thoroughly before the next coat is applied.

628-4.7 CURING. The mixture shall be permitted to dry for a minimum of [ ] hours after the final application before opening to traffic and shall be sufficiently cured to drive over without damage to the seal coat. Any damage to the uncured mixture will be the responsibility of the Contractor to repair.

* *

* A minimum of 24 hours is recommended.

* *

* 628-4.8 HANDLING. The mixture shall be continuously

agitated from the initial mixing until its application on the pavement surface. The distributor or applicator, pumps, and all tools shall be maintained in satisfactory working condition.

QUALITY CONTROL

628-5.1 CONTRACTOR'S CERTIFICATION. The Contractor shall furnish the manufacturer's certification that each consignment of
emulsion shipped to the project meets the requirements of Federal specification R-P-355, except that the water content shall not exceed 50 percent. The certification shall also indicate the solids and ash content of the emulsion and the date the tests were conducted.
The Contractor shall furnish the manufacturer's certification that the latex rubber shipped to the project meets the requirements or the material specified in paragraph 628-2.4. It shall also indicate that the latex and coal-tar emulsion proposed for use are compatible and that the latex is recommended for combining with the coal-tar emulsion, water, and aggregate.
The manufacturer's certification for the emulsion and rubber shall not be interpreted as a basis for final acceptance. Any certification received shall be subject to verification by testing samples received for project use.

The Contractor shall furnish the manufacturer's certification that the combination of latex and coal tar emulsion proposed for use has been successfully used in coal tar emulsion seal coat mixtures for a minimum of three years. The Contractor shall also furnish a certification demonstrating their experience in the application of a rubberized coal-tar emulsion seal coat for a minimum of three years.

All certifications shall be furnished to the Engineer at least 5 days prior to the start of operations.

628-5.2 QUALITY CONTROL. The Contractor shall have an independent technical consultant on the job site at the beginning of operations. The consultant shall have knowledge of the materials, procedures, and equipment described in this specification and shall assist the Contractor regarding proper mixing of the component materials and application of the seal coat. The consultant shall have a minimum of 3 years experience in the use of rubberized coal tar seal coats using 16-20 pounds of aggregate per gallon of emulsion. Documentation of this experience shall be furnished to the Engineer prior to the start of operations. The cost of the technical consultant shall be included in the bid price.

Prior to the start of operations, the independent technical consultant shall perform the viscosity tests in Table 3. The results shall be within ñ 15 poises of the job mix viscosity.

628-5.3 SAMPLING. Two random samples of the composite rubberized sand slurry mix, from each days production, shall be tested for viscosity to determine conformance with the requirements of the job mix formula viscosity for the composite mix, ñ 15 poises. One sample per day may be tested for the other properties of Table 3.

In addition, a one-quart sample will be obtained daily and stored in a glass container. The container shall be sealed against contamination and retained in storage by the owner for a period of six months. Samples shall be stored at room temperature and not be subjected to freezing temperatures.

A sample of undiluted coal tar emulsion and latex shall be sampled from each consignment shipped to the job.

628-5.4 ENGINEER'S RECORDS. The Engineer will keep an accurate record of materials used in formulating each batch of the seal coat.

METHOD OF MEASUREMENT

628-6.1 The coal-tar emulsion shall be measured by the gallon (liter) of undiluted emulsion.

628-6.2 The mineral aggregate shall be measured by the ton (kilogram).

628-6.3 The latex rubber shall be measured by the gallon (liter).

BASIS OF PAYMENT

628-7.1 Payment shall be made at the contract unit price per gallon (liter) for the coal-tar emulsion, per ton (kilogram) for the mineral aggregate[, and per gallon (liter) for the latex rubber. These prices shall fully compensate the Contractor for furnishing all materials; and for all labor, equipment, tools, and incidentals necessary to complete the items.

Payment will be made under:

Item P-628-7.1	Coal-Tar Emulsion -per gallon (liter)
Item P-628-7.2	Aggregate - per ton (kilogram)
Item P-628-7.3	Latex Rubber - per gallon (liter)

TESTING REQUIREMENTS

ASTM 136	Sieve or Screen Analysis of Fine and Coarse Aggregates

MATERIAL REQUIREMENTS

Fed. Spec. P-355	Pitch, Coal-Tar Emulsion (Coating for Bituminous Pavements)
ASTM D 490	Tars, (For Use In Road Construction)

APPENDIX A

MIX DESIGN PROCEDURE

ITEM P-628

MIX DESIGN PROCEDURE ITEM P-628

TEST METHODS

CRITERION

This procedure shall be used to determine the capability of the materials furnished by the contractor to produce a seal coat mix within the range of TABLE 2 and meeting the requirements of TABLE 3.

The formulation is a combination of coal tar emulsion, water, sand, and latex rubber. The samples furnished by the contractor shall be combined in the proportions recommended by the manufacturer and subjected to a sequence of six tests designed to eliminate any materials or combination of materials which do not meet the test criteria. Unacceptable materials in the formulation shall be eliminated from further consideration.

BROOKFIELD VISCOSITY
Step 1 & Step 2

1. Scope
   This method covers the determination of the Brookfield viscosity, using materials and recommended formulations provided by the Contractor. It is designed to detect formulations that have incompatible quantities of latex and coal tar emulsion, that might flocculate, that have viscosities too low to suspend sand, and to identify any incompatibilities created by introducing sand or latex.

2. Definitions
   2.1 Brookfield viscosity - the viscosity determined by this method. The viscosity is expressed in centipoises (100 centipoises = 1 poise). Its value may vary with the spindle speed (shear rate) due to the non-Newtonian behavior of the coal tar emulsion, additive, sand, and the water added.
   2.2 Total liquids - coal tar emulsion, additive, and water.
   2.3 Composite system - total liquids and sand.

3. Apparatus
   3.1 Brookfield digital viscometer (model DV-II) and stand.
   3.2 Number 1 and 3 HB spindles for DV-II viscometer.
   3.3 Paint cans
      3.3.1 quart capacity.
      3.3.2 gallon capacity.

4. Sample preparation for Step 1 (4.1-4.3) and Step 2 (4.1-4.4)
   4.1 Allow components (coal tar emulsion, water, sand, and additive) to reach 77 degrees F. This should take approximately 24 hours.
   4.2 Mix coal tar emulsion and water in container specified in 3.3.2 with 50 strokes of a large laboratory mixing spoon.
   4.3 Introduce additive to the mixture with an additional 50 strokes of the laboratory mixing spoon.

Proceed to Step 1.
4.4 Add sand to total liquids with 50 strokes of a large laboratory mixing spoon, for composite mixture. Sand must be added slowly to avoid trapping air in the mixture. Stir composite mixture for 5 minutes and immediately proceed to Step 2.

5. Procedure

Step 1

5.1 Fill quart paint can specified in 3.3.1 to within one inch of the top with the material prepared in accordance with 4.1 through 4.3.

5.2 Insert spindle No. 3 HB in the material until the mixture level coincides with the immersion groove on the spindle shaft.

5.3 Avoid trapping air bubbles underneath the spindle. 5.4 Adjust rotational speed on the Brookfield viscometer to 50 revolutions per minute (rpm).

5.5 Start motor and record viscosity value in centipoises after five seconds of rotation. If the viscosity reading is too low for spindle 3, repeat procedure 5.1 through 5.5, using spindle No. 1.

Step 2

5.6 Repeat 5.1 - 5.5 with the composite mixture prepared in accordance with 4.1 through 4.4.

5.7 If the composite mixture does not fall within the acceptance criterion of 10 to 90 poises the following procedure for combining materials shall be used.

5.7.1 Discard materials from Step 1.

5.7.2 Mix coal tar emulsion and water in container specified in 3.3.2 with 50 strokes of a large laboratory mixing spoon.

5.7.3 Add sand to the mixture with 50 strokes of the laboratory mixing spoon.

5.7.4 Introduce additive to the mixture with 50 strokes of the laboratory mixing spoon, for composite mixture. Stir composite mixture for 5 minutes and immediately proceed to Step 1.

6. Report

6.1 The report should include:

6.1.1 Date of test and complete identification of the coal tar formulation tested.

6.1.2 Spindle number and rpm setting.

6.1.3 Temperature of the sample tested.

6.1.4 Viscosity of total liquids in poises. (Step 1)

6.1.5 Viscosity of composite system in poises. (Step 2)

Step 1 Criterion: Viscosities between 10 and 90 poises are acceptable
Step 2 Criterion: Viscosities between 10 and 90 poises are acceptable

For materials to move into Step 2 testing the viscosity range must be met in Step 1. Likewise Step 3 will not be continued until viscosity range is met in Step 2 testing. If a material fails to met testing criteria in any step it will be eliminated from further testing.

SCUFF RESISTANCE TEST

Step 3

1. Scope
   This method covers the determination of the initial set and final scuff resistance characteristics of coal tar emulsion seal coat.

2. Definitions
   2.1 Initial set - torque reading at 8 hours of curing. 2.2 Final scuff resistance - torque reading at 24 hours of curing.

3. Apparatus
   3.1 "Scuff" resistance tester similar to the cohesion tester in ASTM D-3910-80a, but modified as follows:
      3.1.1 Proving ring used to measure applied load.
      3.1.2. Screw jack used to apply load.
      3.1.3 5" x 3/4" ID 1 7/32" OD reinforced rubber hose (two braid, 300 psi, green, oil resistant cover) for use in abrasion head.

   3.2 Torque wrench with 300 inch pound capacity.
   3.3 6" x 6" square 16 gauge sheet metal mask with 4" x 4" square center removed.
   3.4 6" x 6" square aluminum panel.

4. Procedure
   4.1 Using mask described in 3.3, apply uniform thickness of coal tar emulsion mixture to two panels as described in 3.4.
   4.2 Allow the sample to cure at 77 degrees F and 50-10 percent relative humidity.
   4.3 Test the first panel after 8 hours of curing.
   4.4 Place panel on lower platen and secure with "c" clamps.
   4.5 Raise platen with screw jack until sample comes

in contact with the rubber abrasion head.
4.6 Continue raising the platen until a normal load of 28 psi, as measured through the dial gage, is applied to the sample.
4.7 Tap platen to ensure proper load is applied to the sample.
4.8 Pull the torque wrench through and arc of 180 degrees in 1-2 seconds.
4.9 Record torque reading in inch-pounds.
4.10 Repeat procedures 4.4 through 4.9 on second sample after 24 hours of curing and record the torque reading in inch-pounds.

5. Report
5.1 Report the following information
5.1.1 Date and material tested.
5.1.2 Initial set as the torque reading at 8 hours of curing.
5.1.3 Final scuff resistance as the torque reading at 24 hours of curing.

CYCLIC FREEZE THAW CONDITIONING
Step 4

1. Scope
This method covers the analysis of crack development in a composite rubberized coal tar emulsion seal coat when exposed to multiple cycles of freezing and thawing.

2. Apparatus
2.1 12" x 12" square 16 gauge sheet metal mask with an 11" x 11" square center removed.
2.2 12" x 12" square section of aluminum panel 3/16" thick.
2.3 Oven capable of maintaining 140 degrees F.
2.4 Freezer capable of maintaining 10 degrees F.

3. Procedure
3.1 Using mask described in 2.1, apply uniform thickness of the composite rubberized coal tar emulsion mixture to a panel as described in 2.2.
3.2 Allow material to cure at 77 + 2 degrees F and 50 + 10 percent relative humidity for 24 hours.
3.3 Place sample in the 140 degree F oven for 24 hours.
3.4 Remove sample and record crack development.
3.5 Place sample in 10 degree F freezer for 24 hours. 3.6 Remove from freezer; this constitutes one freeze-thaw cycle.
3.7 Repeat procedures 3.3 through 3.6 for a total of 10 cycles.
3.8 Inspect the samples after 5 and 10 cycles and rate the cracking in accordance with the following scale and the following procedure:
3.8.1 Using a commercially

available thickness gauge, estimate the width of the largest crack appearing on the surface.

3.8.2 Next, place a grid frame over the coal tar seal coated shingle (after freeze/thaw conditioning). The grid is a wood frame with an inside diameter of 12x12inches. A grid is formed across the inside opening of the frame by subdividing the opening into 10 equal divisions both horizontally and vertically with twine anchored to the frame. This will provide 100 equally sized squares.

3.8.3 Count the number of squares in which a crack occurs. The percent cracking is equal to the number of squares.

3.8.4 Compare the results to table below:

Severity of Cracking	Width of Widest Crack	Percent of Cracking
Hairline	0.010 mm	NA-Cracks are barely
visible Slight Cracking		0.015 mm
<25%		
Moderate Cracking	0.020 mm	>25%
Severe Cracking	0.020 mm or greater	>50%

0 - No cracking
1 - Hairline cracking
2 - Slight cracking
3 - Moderate cracking
4 - Severe cracking

4. Report

4.1 Report the crack rating at 5 and 10 cycles.

Step 4 Criterion: Rating of 1 or less at 5 cycles is required. Rating of 3 or less at 10 cycles is required.

Any materials not meeting this requirement shall be eliminated from Step 5.

ADHESION
Step 5

1. Scope

This method covers the determination of adhesion of a composite rubberized coal tar emulsion seal coat and retention of sand by applying pressure sensitive tape.

2. Apparatus

2.1 12" X 12" square 16 gauge sheet metal with 3" X 6" rectangular center removed.
2.2 12" X 12" aluminum panel 3/16" thick.
2.3 Razor sharp blade, scalpel, or other cutting device with cutting edge in good condition.
2.4 Steel straight edge.
2.5 One inch wide semi-transparent pressure sensitive tape with an adhesion strength of 38 + 5 oz./in. when tested in accordance with ASTM D 3330. The backing of the tape may consist of fiber-reinforced cellulose acetate, unplasticized polyvinyl chloride, or polyester film.
2.6 Hard, small head rubber eraser.
2.7 Table lamp.

3. Procedure

3.1 Using the mask described in 2.1, apply a uniform thickness of the composite mixture to the aluminum panel as described in 2.2.
3.2 Allow mix to cure at 77 + 2 degrees at 50 + 10 percent relative humidity for 24 hours.
3.3 Select a representative area.
3.4 Make a horizontal cut of about 1.5 inches. Then make another cut of 1.5 inches about 40 degrees to the horizontal cut. The cuts should intersect each other at their centers. When making the cuts, use the straight edge and cut through the coating to the substrate in on steady motion. Brush off dislodged materials.
3.5 Inspect the cuts for reflection of light from the metal substrate to establish that the coating has been cut through completely. If the substrate has not been reached, do not attempt to deepen the cut. Instead, make another "X" in a different location. Remove the dislodged materials by brushing lightly.
3.6 Remove two laps of the pressure sensitive tape from the roll and discard. Remove an additional length at a steady rate and cut a piece about three inches long.
3.7 Place the center of the tape at the intersection of the cuts with the tape running in the same direction as the smaller angles. Smooth out the tape in the area of the cuts and then rub firmly with the eraser.
3.8 Wait for 60 seconds, then rapidly pull one end of the tape back on itself with the non-stick surfaces touching and running parallel to each other.
3.9 Inspect the "X" cut area for removal of the coating from the substrate and rate the adhesion in accordance with the following scale:

5A No Peeling or removal
4A Trace peeling or removal along incisions
3A Jagged removal along incisions up to 1/16 inch either

side to 1/8

2A Jagged removal along most incisions Up to l/8 inch on either side

1A Removal from most of the area of the "X" under the tape

0A Removal beyond the area of the "X"

3.10 Inspect the tape for adhesion of sand.

3.11 Repeat the test in two other locations on the test panel.

4 Report

4.1 Report the number of tests, their mean value and range.

4.2 Report whether sand adhered to the tape as yes or no.

Step 5 criterion: No sand can adhere to the tape. No debonding of the seal coat or the test medium is allowed (adhesion rating of 5A is required).

Any materials not meeting this requirement shall be eliminated from being tested in Step 6.

FUEL RESISTANCE
Step 6

1. Scope

This method determines the resistance of the composite rubberized coal tar emulsion seal coat to kerosene.

2. Apparatus

2.1 2 6" X 6" square 16 gauge sheet metal masks with a 4" by 4" square center removed.

2.2 6" X 6" unglazed white ceramic tile with an absorption rate of 10-18 percent (determined in accordance with ASTM C 67.

2.3 Brass ring, 2" diameter and 2" high.

2.4 Kerosene meeting requirements of ASTM D 3699.

2.5 Silicone rubber sealant.

3. Procedure

3.1 Immerse the ceramic tile in distilled water for a minimum of ten minutes.

3.2 Remove excess water from the tile to produce a damp surface before applying the seal coat.

3.3 Using the mask described in 2.1 apply one layer of the composite coal tar emulsion mixture to the tile. Spread even with the top of the mask using a spatula or other straight edge.

3.4 Allow the sample to cure for 96 hours at 77 + 2 degrees F. and 50 + 10 percent relative humidity.

3.5 After curing, affix the brass ring to the seal coat on the tile with silicone rubber.

3.6 Fill the brass ring with kerosene.

3.7 After 24 hours, remove the kerosene from the brass ring, blot dry and immediately examine the film for softness and loss of adhesion. Immediately after the film is examined, break the tile in half, exposing that part of the tile whose film was subjected to the kerosene.

3.8 Evaluate for penetration of kerosene through the sealer and loss of adhesion.

4. Report

4.1 Report the results as pass or fail. Visible evidence of leakage or discoloration shall constitute failure of the test.

Step 6 Criterion: A "pass" rating in the fuel resistance test is required.