APPENDIX B – PRIME AND TACK COAT INSPECTION BULLETS

PRIME COAT

- Prior to priming, assure placement of the aggregate base course is in accordance with the plans and specifications. A prime coat is not a substitution for maintaining the specified condition of the aggregate base course prior to paving.
  - Assure grade tolerances are met.
  - Assure proper crown exists.
  - Assure no raveling or segregated areas exist.
  - Assure specified moisture and density requirements are maintained.
- Complete a 300 m (1000 ft) test strip to determine proper application rate.
  - Follow proper asphalt distributor construction procedures to prevent streaking and allow proper application rate and uniform coverage.
    - The spray bar nozzles should be set at an angle of 15 to 30 degrees to the horizontal axis of the spray bar to prevent the spray of liquid asphalt from interfering with adjacent spray nozzles. Most nozzles are set at 30 degrees as shown in Figure 32.

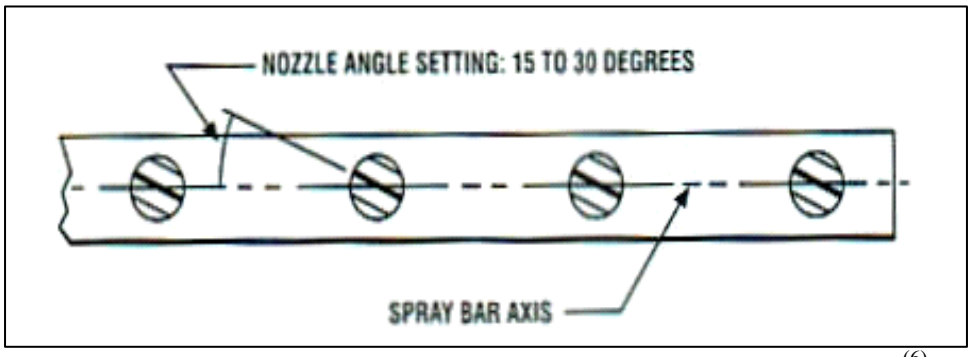

Figure 32. Schematic. Recommended spray bar nozzle settings [6].

    - The height of the spray bar should be set to allow for an exact single, double or triple overlap as shown in Figure 33. Other than an exact single, double or triple overlap will result in streaking and non-uniform application rates as shown in Figure 34. A double overlap is recommended for most prime applications.
    - For uniform application, proper spray bar height must be maintained during application. This requires that the spray bar height be adjustable to correct for the truck's rear springs rising as the load lessens.
  - Select an appropriate initial application rate for the type of aggregate base course present.
    - Application rates are a function of the openness of the aggregate base and can vary slightly with the absorption of the aggregate. Open graded bases will require more prime than dense graded bases.

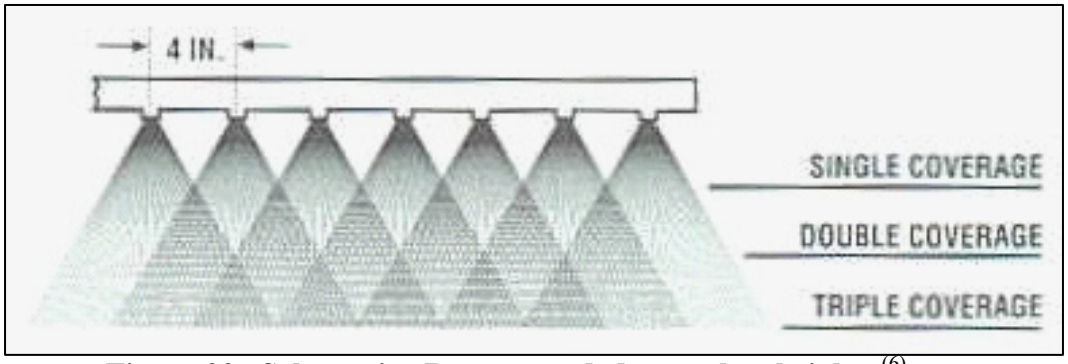

Figure 33. Schematic. Recommended spray bar heights [6].

Figure 34. Photo. Streaking in spray application caused by improper pump pressure and/or spray bar height.

- Good practice is to start at 0.90 L/m^2 (0.20 gal/yd^2) and adjust as necessary.
- Apply asphalt cutback prime and specially formulated penetrating asphalt emulsion prime at an application rate of 0.45 to 2.25 L/m^2 (0.10 to 0.50 gal/yd^2) for optimum penetration.
- Apply non special formulated emulsified asphalt for prime at an application rate of 0.45 to 1.35 L/m^2 (0.10 to 0.30 gal/yd^2) for optimum penetration.

o No more prime should be applied than can be absorbed by the aggregate base in 24 hours.

- Prime oil that balls up may be an indication of too little prime. Increase the application rate in 0.20 L/m^2 (0.05 gal/yd^2) increments.
- Fat spots or puddling is an indication of too much prime. Decrease the application rate in 0.20 L/m^2 (0.05 gal/yd^2) increments.

- The major purpose of prime coat is to protect the underlying layers from wet weather by providing a temporary waterproofing layer. Additional benefits of prime coat are stabilizing or binding the surface fines together and promoting bond to the HMA layer.
  - Prime must adequately penetrate the aggregate base course to perform the above functions.
  - Adequate penetration to be effective has been reported as a minimum of 5 to 10 mm (0.25 to 0.5 in). Figure 35 shows typical penetration of an MC prime into a dense graded crushed stone base.

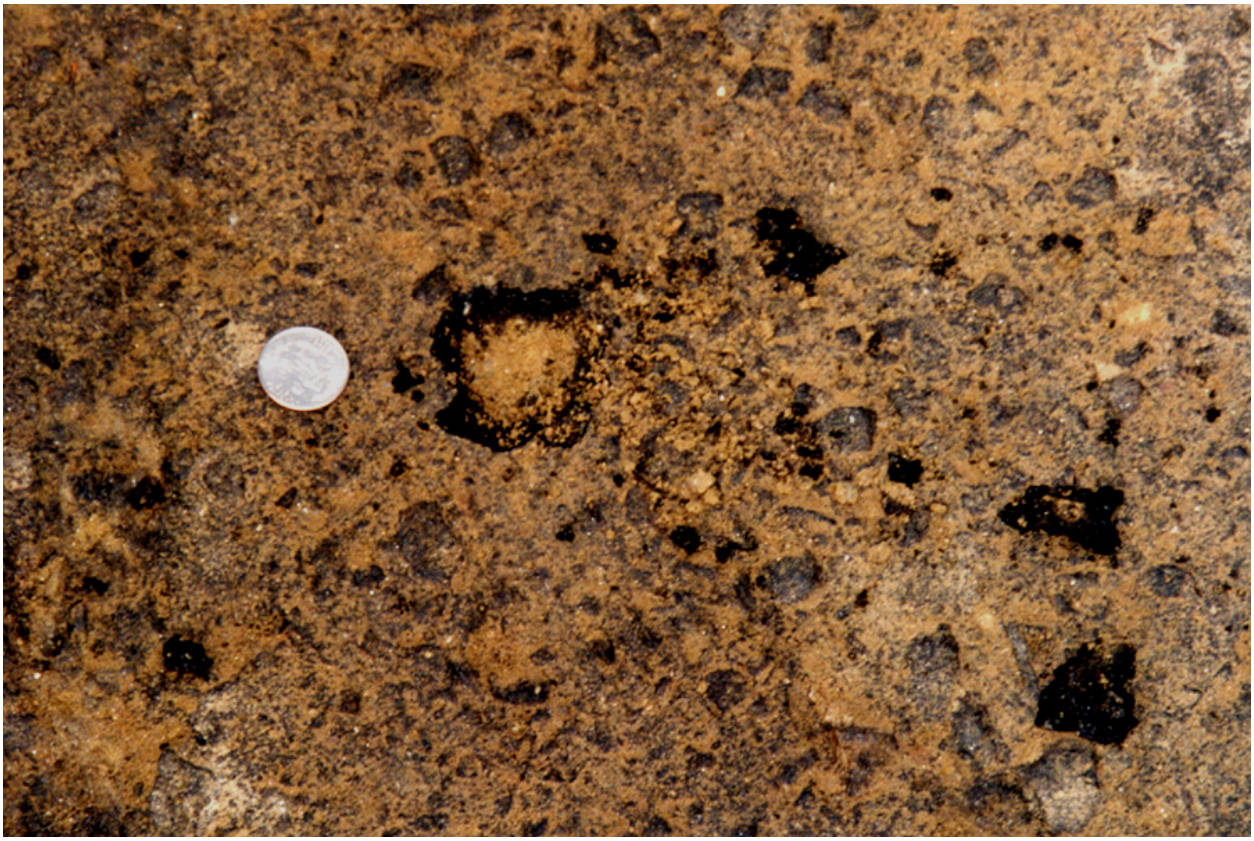

Figure 35. Photo. Typical penetration of MC-70 prime into a dense graded aggregate base.

  - Regular asphalt emulsions are not usually suitable for use as prime coat because they will not penetrate the surface unless diluted with water. Bases with a high percentage of fine grained materials, passing 0.075 mm (#200) sieve, act as a filter and will not let emulsified asphalt particles penetrate. Mechanical mixing or scarification of the surface to a depth of 25 to 50 mm (1 to 2 in) is recommended to produce an acceptable prime when asphalt emulsions are used. Figure 36 shows the lack of penetration of prime onto a base which was caused by too high a viscosity of the prime when applied and the high fines content of the base.

Figure 36. Photo. Poor penetration of prime caused by the high fines content of the base.

- The surface of the aggregate base course should be slightly damp prior to application of prime materials.
  - Water may be added to the surface of the aggregate base course to achieve a slightly damp condition.
  - A damp surface lowers application rates by preventing excess absorption of the prime by the aggregates.
  - A damp surface helps prevent balling of the prime with dust particles on the surface and aids in penetration.
- For uniform application the proper viscosity of the prime coat material must be maintained.
  - This is achieved by heating MC cutbacks.
  - This is achieved by occasionally heating asphalt emulsions or diluting them with water.
  - Figure 37 shows the results of applying prime when the viscosity of the material was too high.
  - Table 9 provides recommended spray temperatures for prime coat application.

Figure 37. Photo. Results of applying prime at too high viscosity.

Table 9. Recommended spray temperature range for prime coat.

Type and Grade of Asphalt	Temperature Range	
	°C	°F
SS-1, SS-1h, CSS-1, CSS-1h[1]	20-70	70-160
MC-30[1]	30+	85+
MC-70[1]	50+	120+
MC-250[1]	75+	165+
AE-P[2]	49-82	120-180
EAP&T[2]	15-38	60-100

[1] Reference (6)
[2] Reference (20)

- Any excess prime that is not absorbed into the aggregate base course after 24 hours should be removed with blotter sand to prevent wash off into waterways and tracking and pickup of the material by traffic.
  - Recommended blotter sand application rates are 2.2 to 4.4 kg/m^2 (4 to 8 lbs/yd^2).
  - Blotter sand should be applied using a mechanical devise such as a salt or chip spreader. Dumping blotter sand with a loader and spreading with a shovel should be avoided.
  - Excess blotter sand should be broomed from the surface before HMA placement to ensure a proper bond.

- Prime coat must cure completely to function properly.
  Prime coats generally take several days to properly cure so they can withstand construction traffic.
  - The curing of prime coat depends upon the weather. If the weather is hot the prime coat will cure quickly but if the weather is cool and damp the prime coat will cure slowly.
  - Emulsified products generally cure faster than cutback asphalts.
    - Asphalt emulsions require a minimum of 24 hours to fully cure.
    - Cutbacks require a minimum of 72 hours to fully cure.
  - It is riskier to place an HMA layer over an uncured prime coat than an unprimed base, because the uncured prime can cause more base movement than construction on an unprimed base. Excessive prime remaining on the surface can be absorbed into overlying asphalt layers and the solvents in the prime used to liquefy the asphalt, typically kerosene or diesel fuel, can damage the asphalt layer quickly, contributing to pavement slippage or rutting and lateral movement of the asphalt concrete during rolling operations.
  - At a minimum, construction traffic should be kept off a fresh prime coat until cured sufficiently to prevent tracking and rutting of the prime.
- Weather and temperature limitations.
  - The curing of prime coat depends upon the weather.
  - Prime coat may be omitted in cold weather because prime materials cure slowly at low temperatures.
  - Prime should not be applied unless the air temperature in the shade and the pavement temperature are 10°C (50°F) and rising and when the weather is not foggy or rainy.
- Existing structures should be protected from application of prime coat materials.
  - Curbs, gutters, manhole inlets, etc. should not be primed. The vertical edges of these structures receive a tack coat.
  - All structures, including existing retaining walls, sidewalks, curbs, gutters, manhole inlets, etc. should be protected from accidental spray of prime coat materials.
  - Structures can be protected from overspray, wind drift and splatter by using a shield, such as plywood, or by covering the structure with plastic sheeting or other suitable material.
- The inspector should keep track of the yield and quantities of prime coat material, blotter sand and dilution water.

TACK COAT

- Prior to tacking, assure the condition of the existing surface is in accordance with the plans and specifications. A tack coat is not a substitution for properly cleaning the existing surface.
- Complete a 300 m (1000 ft) test strip to determine proper application rate.
  - Follow proper asphalt distributor construction procedures to prevent streaking and allow proper application rates and uniform coverage.
    - The spray bar nozzles should be set at an angle of 15 to 30 degrees to the horizontal axis of the spray bar to prevent the spray of liquid asphalt from interfering with adjacent spray nozzles. Most nozzles are set at 30 degrees, as shown in Figure 32.
    - The height of the spray bar should be set to allow for an exact single, double or triple overlap, as shown in Figure 33. Other than an exact single, double or triple overlap will result streaking and non uniform application rates. A double overlap is recommended for most tack applications. Figure 38 shows streaky application caused

by improper spray bar height or pump pressure. Note that the distributor is traveling in the wrong direction, driving over the freshly applied tack.

- For uniform application, proper spray bar height must be maintained during application. This requires that the spray bar height be adjustable to correct for the truck's rear springs rising as the load lessens.
- A streaked tack coat can be rolled with a pneumatic roller prior to the asphalt emulsion breaking to improve uniformity of application.

Figure 38. Photo. Streaking in tack coat caused by improper spray bar height and/or pump pressure.

- Select an appropriate initial application rate for the type of surface. Table 10 provides recommended tack coat application rates.
  - Application rates typically vary from 0.15 to 0.70 L/m^2 (0.03 to 0.15 gal/yd^2).
  - Good practice is to start at 0.20 L/m^2 (0.05 gal/yd^2) and adjust as necessary.

➢ For uniform application, the proper viscosity of the tack coat material must be maintained.
- This is achieved by heating asphalt emulsions or diluting them with water.
- Application of tack at too high a viscosity will result in non uniform application.
- Table 11 provides recommended application temperatures for tack coat materials.

Table 10. Recommended tack coat application rates [21].

Existing Pavement Condition	Application Rate			
	Undiluted[1]		Diluted (1:1)[2]	
	(L/m^2)	(gal/yd^2)	(L/m^2)	(gal/yd^2)
New Asphalt	0.20 to 0.30	0.05 to 0.07	0.40 to 0.60	0.10 to 0.13
Oxidized Asphalt	0.30 to 0.45	0.07 to 0.10	0.60 to 0.90	0.13 to 0.20
Milled Surface (asphalt)	0.45 to 0.60	0.10 to 0.13	0.90 to 1.20	0.20 to 0.27
Milled Surface (PCC)	0.45 to 0.60	0.10 to 0.13	0.90 to 1.20	0.20 to 0.27
Portland Cement Concrete	0.30 to 0.45	0.07 to 0.10	0.60 to 0.90	0.13 to 0.20
Vertical Face[3]				

[1] Asphalt emulsion meeting requirements of AASHTO M 140, Table 1.
[2] Asphalt emulsion meeting requirements of AASHTO M 140, Table 1, diluted with equal parts water and asphalt emulsion.
[3] Longitudinal construction joints should be treated using a rate that will thoroughly coat the vertical face without running off.

Table 11. Recommended application temperatures for tack coat materials.

Type and Grade of Asphalt	Temperature Range	
	^oC	^oF
SS-1, SS-1h, CSS-1, CSS-1h[1]	20-70	70-160
MS-1, MS-2, MS-2h, CMS-2, CMS-2h[1]	20-70	70-160

[1] Reference [6]

- Traffic, both construction and local, should be kept off fresh tack.
  - A freshly applied tack coat surface is too slick for safe driving, particularly before the asphalt emulsion has broken.
  - Traffic should be kept off the tack coat until no hazardous conditions exist.
  - Drivers should be warned of the probability of the asphalt emulsion splattering when traffic is permitted on a tack coat.
  - To limit disruption of traffic and to keep traffic off the fresh tack, minimize the length ahead of the asphalt laydown operation that the tack is applied.
- Weather and temperature limitations.
  - The curing rate of tack depends upon the weather.
  - Apply asphalt tack coat on a dry, unfrozen surface when the air temperature in the shade is above 2^oC (35^oF) and rising.
- The vertical surfaces of transverse joints, longitudinal joints, curbs, gutters, manhole inlets, etc. should receive a tack coat.
  - Tack should be applied uniformly and completely by fogging with a hand spray attachment or by another approved method.
  - If excess asphalt material is applied, squeegee the excess from the surface.
- Existing structures should be protected from application of tack coat materials.
  - All structures, including existing retaining walls, sidewalks, curbs, gutters, manhole inlets, etc. should be protected from accidental spray of tack coat materials.
  - Structures can be protected from overspray, wind drift and splatter by using a shield, such as plywood, or by covering the structure with plastic sheeting or other suitable material
- The inspector should keep track of the yield and quantities of tack coat material.

APPLICATION RATES

- The following formulas can be used to determine the volume of prime or undiluted tack coat, at the delivered temperature, required to cover a test section at the specified application rate, when the specified application rate is for undiluted material.
  - In SI units:

    Volume of material at delivered temperature = (AR * A) / M

    Where:

    AR = application rate at 15.6°C in L/m^2 of material (cutback or asphalt emulsion)

    A = area of test section (length * spray bar length) in m^2

    M = multiplier for correcting volumes to the basis of 15.6°C as shown in Tables 12 for cutbacks and 13 for asphalt emulsions.

    - Example:

      Desired application rate (AR) = 0.90 L/m^2 of MC-70

      Test section length = 300 m

      Spray bar length = 4.0 m

      Temperature of prime as delivered = 60°C

      Multiplier (M) = 0.9686 from Table 12

      Area (A) = 300 m * 4.0 m = 1,200 m^2

      Volume of prime required = (AR * A) / M

      = (0.90 L/m^2 * 1,200 m^2) / 0.9686 = <u>1,115 L</u>

  - In English units:

    Volume of material at delivered temperature = (AR * A) / (9 ft^2/yd^2 * M)

    Where:

    AR = application rate at 60°F in gal/yd^2 of material (cutback or asphalt emulsion)

    A = area of test section (length * spray bar length) in ft^2

    M = multiplier for correcting volumes to the basis of 60°F as shown in Tables 12 for cutbacks and 13 for asphalt emulsions.

    - Example:

      Desired application rate (AR) = 0.20 gal/yd^2 MC-70

      Test section length = 1000 ft

      Spray bar length = 13 ft

      Temperature of prime as delivered = 140°F

      Multiplier (M) = 0.9686 from Table 12

      Area (A) = 1000 ft * 13 ft = 13,000 ft^2

      Volume of prime required = (AR * A) / (9 ft^2/yd^2 * M)

      = (0.20 gal/yd^2 * 13,000 ft^2) / (9 ft^2/yd^2 * 0.9686) = <u>298 gal</u>

- The following formulas can be used to determine the volume of diluted prime or tack coat, at the delivered temperature, required to cover a test section at the specified application rate, when the specified application rate is for undiluted material.
  - In SI units:

    Volume of material at delivered temperature = [(AR / (D/100)) * A] / M

    Where:

    AR = application rate at 15.6°C in L/m^2 of diluted asphalt emulsion

    D = percent dilution

    A = area of test section (length * spray bar length) in m^2

    M = multiplier for correcting volumes to the basis of 15.6°C as shown in Table 13 for asphalt emulsions.

    - Example:

      Desired application rate (AR) = 0.20 L/m^2 of 1:1 diluted CSS-1

      Test section length = 300 m

      Spray bar length = 3.66 m

      Temperature of tack as delivered = 50°C

      Multiplier (M) = 0.98450 from Table 13

      Area (A) = 300 m * 3.66 m = 1,098 m^2

      D = 50 percent dilution

      Volume of tack required = [(AR / (D/100)) * A] / M

      = [(0.20 L/m^2 / (50/100))* 1,098 m^2] / 0.98450 = <u>446 L</u>

  - In English units:

    Volume of material at delivered temperature = [(AR / (D/100)) * A] / (9 ft^2/yd^2 * M)

    Where:

    AR = application rate at 60°F in gal/yd^2 of undiluted asphalt emulsion.

    D = percent dilution.

    A = area of test section (length * spray bar length) in ft^2

    M = multiplier for correcting volumes to the basis of 60°F as shown in Table 13 for asphalt emulsions.

    - Example:

      Desired application rate (AR) = 0.05 gal/yd^2 of 1:1 diluted CSS-1

      Test section length = 1000 ft

      Spray bar length = 12 ft

      Temperature of tack as delivered = 122°F

      Multiplier (M) = 0.98450 from Table 13

      Area (A) = 1000 ft * 12 ft = 12,000 ft^2

      Volume of tack required = [(AR / (D/100)) * A] / (9 ft^2/yd^2 * M)

      = [(0.05 gal/yd^2 / (50/100)) * 12,000 ft^2) / (9 ft^2/yd^2 * 0.98450) = <u>135 gal</u>

ENVIRONMENTAL ISSUES

- The primary pollutants of concern from asphalt paving operations are volatile organic compounds (VOC). Cutback asphalts are the major source of VOCs as only minor amounts of VOCs are emitted from emulsified asphalts and asphalt cements.
  - The use of cutback asphalt is regulated in many jurisdictions to help reduce VOC emissions. Prohibitions on the use of cutback, either permanently or during certain times of the year, are common in jurisdictions that have either reached, or are nearing non-attainment for ozone requirements of the Clean Air Act.
  - Asphalt emulsions are typically used in place of cutback asphalts to eliminate VOC emissions.
  - Local, state and federal regulations should be consulted for specific requirements and regulations regarding use of cutback asphalts.
- Liquid asphalt products, including prime and tack coats, must be kept out of waterways.
  - Water quality issues are complex because of the overlapping jurisdiction of several federal agencies, the complexity of many of the regulations, and the variability of regulations and jurisdictions on the state and local levels.
  - Local, state and federal regulations should be consulted for specific reporting and remediation requirements and for regulations regarding water quality issues with use of cutback and asphalt emulsions.
  - A direct spill into a waterway is not the only way prime or tack coat materials can enter a waterway. Entry is available through a spill that enters storm water and waste water sewers, drainage ditches, etc., to name but a few sources. Additionally, rain water could wash a freshly applied uncured prime coat into a waterway as shown in Figure 39.
  - Prime should not be placed if there is a high probability of rain within 24 hours of application or before the prime can be fully absorbed into the base and any excess removed with blotter sand.
  - Prime coat should be omitted if there is a strong possibility of runoff entering a waterway.
  - The requirements of the contractors Storm Water Pollution Prevention Plans (SWP3), required by the storm water permit process for construction sites, should be in place and in working order prior to application of prime or tack.
  - A spill or accidental release should be contained immediately by diking or impounding. Do not allow spills to enter sewers or watercourse. Remove all sources of ignition. Absorb with appropriate inert materials such as sand, clay, etc. Notify appropriate authorities of spill. The spill may be a regulated waste. If regulated solvents are used to clean up the spilled material, the resulting waste mixture may be a regulated waste. Assure conformity with local, state and federal governmental regulations for disposal.

Figure 39. Photo. Prime runoff caused by rain shower on freshly applied prime.

Table 12. Temperature - volume corrections for cutback asphlats [74].

°C	°F	M	°C	°F	M	°C	°F	M
21.1	70	0.9960	46.1	115	0.9783	71.1	160	0.9609
21.7	71	0.9956	46.7	116	0.9779	71.7	161	0.9605
22.2	72	0.9952	47.2	117	0.9775	72.2	162	0.9601
22.8	73	0.9948	47.8	118	0.9771	72.8	163	0.9597
23.3	74	0.9944	48.3	119	0.9767	73.3	164	0.9593
23.9	75	0.9940	48.9	120	0.9763	73.9	165	0.9589
24.4	76	0.9936	49.4	121	0.9760	74.4	166	0.9585
25.0	77	0.9932	50.0	122	0.9756	75.0	167	0.9582
25.6	78	0.9929	50.6	123	0.9752	75.6	168	0.9578
26.1	79	0.9925	51.1	124	0.9748	76.1	169	0.9574
26.7	80	0.9921	51.7	125	0.9744	76.7	170	0.9570
27.2	81	0.9917	52.2	126	0.9740	77.2	171	0.9566
27.8	82	0.9913	52.8	127	0.9736	77.8	172	0.9562
28.3	83	0.9909	53.3	128	0.9732	78.3	173	0.9559
28.9	84	0.9905	53.9	129	0.9728	78.9	174	0.9555
29.4	85	0.9901	54.4	130	0.9725	79.4	175	0.9551
30.0	86	0.9897	55.0	131	0.9721	80.0	176	0.9547
30.6	87	0.9893	55.6	132	0.9717	80.6	177	0.9543
31.1	88	0.9889	56.1	133	0.9713	81.1	178	0.9539
31.7	89	0.9885	56.7	134	0.9709	81.7	179	0.9536
32.2	90	0.9881	57.2	135	0.9705	82.2	180	0.9532
32.8	91	0.9877	57.8	136	0.9701	82.8	181	0.9528
33.3	92	0.9873	58.3	137	0.9697	83.3	182	0.9524
33.9	93	0.9869	58.9	138	0.9693	83.9	183	0.9520
34.4	94	0.9865	59.4	139	0.9690	84.4	184	0.9517
35.0	95	0.9861	60.0	140	0.9686	85.0	185	0.9513
35.6	96	0.9857	60.6	141	0.9682	85.6	186	0.9509
36.1	97	0.9854	61.1	142	0.9678	86.1	187	0.9505
36.7	98	0.9850	61.7	143	0.9674	86.7	188	0.9501
37.2	99	0.9846	62.2	144	0.9670	87.2	189	0.9498
37.8	100	0.9842	62.8	145	0.9666	87.8	190	0.9494
38.3	101	0.9838	63.3	146	0.9662	88.3	191	0.9490
38.9	102	0.9834	63.9	147	0.9659	88.9	192	0.9486
39.4	103	0.9830	64.4	148	0.9655	89.4	193	0.9482
40.0	104	0.9826	65.0	149	0.9651	90.0	194	0.9478
40.6	105	0.9822	65.6	150	0.9647	90.6	195	0.9475
41.1	106	0.9818	66.1	151	0.9643	91.1	196	0.9471
41.7	107	0.9814	66.7	152	0.9639	91.7	197	0.9467
42.2	108	0.9810	67.2	153	0.9635	92.2	198	0.9463
42.8	109	0.9806	67.8	154	0.9632	92.8	199	0.9460
43.3	110	0.9803	68.3	155	0.9628	93.3	200	0.9456
43.9	111	0.9799	68.9	156	0.9624	93.9	201	0.9452
44.4	112	0.9795	69.4	157	0.9620	94.4	202	0.9448
45.0	113	0.9791	70.0	158	0.9616	95.0	203	0.9444
45.6	114	0.9787	70.6	159	0.9612	95.6	204	0.9441
						96.1	205	0.9437

M = multiplier for converting oil volumes to the basis of 15.6 °C (60 °F)

Table 13. Temperature - volume corrections for asphalt emulsions [6].

°C	°F	M	°C	°F	M	°C	°F	M
10.0	50	1.0025	35.0	95	0.9912	60.0	140	0.9800
10.6	51	1.0022	35.6	96	0.9910	60.6	141	0.9797
11.1	52	1.0020	36.1	97	0.9907	61.1	142	0.9795
11.7	53	1.0017	36.7	98	0.9905	61.7	143	0.9792
12.2	54	1.0015	37.2	99	0.9902	62.2	144	0.9790
12.8	55	1.0012	37.8	100	0.9900	62.8	145	0.9787
13.3	56	1.0010	38.3	101	0.9897	63.3	146	0.9785
13.9	57	1.0007	38.9	102	0.9895	63.9	147	0.9782
14.4	58	1.0005	39.4	103	0.9892	64.4	148	0.9780
15.0	59	1.0002	40.0	104	0.9890	65.0	149	0.9777
15.6	60	1.0000	40.6	105	0.9887	65.6	150	0.9775
16.1	61	0.9997	41.1	106	0.9885	66.1	151	0.9772
16.7	62	0.9995	41.7	107	0.9882	66.7	152	0.9770
17.2	63	0.9992	42.2	108	0.9880	67.2	153	0.9767
17.8	64	0.9990	42.8	109	0.9877	67.8	154	0.9765
18.3	65	0.9987	43.3	110	0.9875	68.3	155	0.9762
18.9	66	0.9985	43.9	111	0.9872	68.9	156	0.9760
19.4	67	0.9982	44.4	112	0.9870	69.4	157	0.9757
20.0	68	0.9980	45.0	113	0.9867	70.0	158	0.9755
20.6	69	0.9977	45.6	114	0.9865	70.6	159	0.9752
21.1	70	0.9975	46.1	115	0.9862	71.1	160	0.9750
21.7	71	0.9972	46.7	116	0.9860	71.7	161	0.9747
22.2	72	0.9970	47.2	117	0.9857	72.2	162	0.9745
22.8	73	0.9967	47.8	118	0.9855	72.8	163	0.9742
23.3	74	0.9965	48.3	119	0.9852	73.3	164	0.9740
23.9	75	0.9962	48.9	120	0.9850	73.9	165	0.9737
24.4	76	0.9960	49.4	121	0.9847	74.4	166	0.9735
25.0	77	0.9957	50.0	122	0.9845	75.0	167	0.9732
25.6	78	0.9955	50.6	123	0.9842	75.6	168	0.9730
26.1	79	0.9952	51.1	124	0.9840	76.1	169	0.9727
26.7	80	0.9950	51.7	125	0.9837	76.7	170	0.9725
27.2	81	0.9947	52.2	126	0.9835	77.2	171	0.9722
27.8	82	0.9945	52.8	127	0.9832	77.8	172	0.9720
28.3	83	0.9942	53.3	128	0.9830	78.3	173	0.9717
28.9	84	0.9940	53.9	129	0.9827	78.9	174	0.9715
29.4	85	0.9937	54.4	130	0.9825	79.4	175	0.9712
30.0	86	0.9935	55.0	131	0.9822	80.0	176	0.9710
30.6	87	0.9932	55.6	132	0.9820	80.6	177	0.9707
31.1	88	0.9930	56.1	133	0.9817	81.1	178	0.9705
31.7	89	0.9927	56.7	134	0.9815	81.7	179	0.9702
32.2	90	0.9925	57.2	135	0.9812	82.2	180	0.9700
32.8	91	0.9922	57.8	136	0.9810	82.8	181	0.9697
33.3	92	0.9920	58.3	137	0.9807	83.3	182	0.9695
33.9	93	0.9917	58.9	138	0.9805	83.9	183	0.9692
34.4	94	0.9915	59.4	139	0.9802	84.4	184	0.9690
						85.0	185	0.9687

M = multiplier for converting oil volumes to the °C (60°F)