Section 904. ASPHALTIC MATERIALS

904.01. General Requirements. The certification program described in the Materials Quality Assurance Procedures Manual governs the asphalt binders in Table 904-2 and the emulsified asphalts in Table 904-4, Table 904-5, and Table 904-6. The Contractor may use materials listed in Table 904-2 through Table 904-6 on MDOT projects, if tested and approved for use in accordance with MDOT procedures.

The Engineer will notify the Contractor and the supplier to correct materials if test results for the requirements from Table 904-2, Table 904-3, Table 904-4, Table 904-5 and Table 904-6 deviate from the specified range.

Asphaltic materials testing will be in accordance with the specified ASTM, AASHTO or Department methods, as modified by this section.

904.02. Application Temperatures. Apply asphaltic materials at temperatures specified in Table 904-7.

904.03. Specific Requirements.

A. **Asphalt Binder.** Asphalt binder must be homogeneous, water-free, and must not foam when heated to the maximum temperature specified in Table 904-7 for the material required.

If using an anti-foaming agent, use a dimethyl polysiloxane type silicone material, preferably 1,000 centistoke viscosity grade, unless otherwise approved by the Engineer. Do not add amounts greater than 5 parts per million unless approved by the Engineer. Mechanically mix the asphalt binder after adding anti-foaming agent while in storage at the asphalt plant.

Asphalt cement must be prepared by refining crude petroleum with or without the addition of modifiers. Asphalt cement prepared with used motor oil is not allowed.

The Engineer will allow organic, virgin or recycled modifiers dissolved, dispersed, or reacted in asphalt cement to enhance performance.

Asphalt binder must be at least 99.0 percent soluble in accordance with AASHTO T 44 or ASTM D 5546.

This specification is not applicable for asphalt binders in which fibers or other discrete particles are larger than 250 micrometers in size.

B. **Cut-Back Asphalt.** Cutback asphalt must meet the requirements of Table 904-3 and this subsection.

Liquid asphalt must be homogeneous, must not foam when heated to the maximum required temperature and must be water-free unless otherwise required.

Caution: Use caution when heating cut-back asphalt, especially RC and MC asphaltic products containing naphtha and kerosene cutback asphalt, since the temperatures for use are near or above the flash points. If using heated cutbacks, keep open flames away from pugmill enclosures, tank car domes, distributor tank openings, and storage tank openings.

C. **Emulsified Asphalt.** Emulsified asphalt must meet the requirements of either Table 904-4, Table 904-5, or Table 904-6 and be made from asphalt having a negative spot test result using 35% xylene / 65% heptane solvent, Aniline No: 30 C ± 2 degrees, AASHTO T 102. It must be homogeneous and show no separation of asphalt after thorough mixing, for a period of at least 30 days after delivery.

D. **Polyester Fibers for Overband Crack Fill.** Provide General Certification for polyester fibers used for overband crackfill. Polyester fibers must meet the requirements of Table 904-1.

Table 904-1
Polyester Fiber Characteristics

Characteristic	Requirement	Test
Length	6.4 mm ± 0.05 mm	—
Crimps	None	ASTM D 3937
Tensile strength	≥480 MPa	ASTM D 2256 (a)
Denier	3.0–6.0	ASTM D 1577 (a)
Specific gravity	1.32–1.40	—
Melting temperature	≥245 °C	—
Ignition temperature	≥540 °C	—

a. Obtain this data before cutting the fibers.

Table 904-2
Performance Graded Asphalt Binder Specification

Performance Grade	**PG 46**			**PG 52**							**PG 58**				
	−34	−40	−46	−10	−16	−22	−28	−34	−40	−46	−16	−22	−28	−34	−40
Avg 7-day Max. Pavement Design Temp, °C (a)	46			52							58				
Minimum Pavement Design Temp, °C (a)	−34	−40	−46	−10	−16	−22	−28	−34	−40	−46	−16	−22	−28	−34	−40
Original Binder															
Flash Point Temp, T48/D 92: Min.	230 °C			230 °C							230 °C				
Viscosity, T 316/D 4402: Max. 3 Pa•s, Test Temp (b)	135 °C			135 °C							135 °C				
Dynamic Shear, T 315/D 7175: G*/sin θ, Min. 1.00 kPa Test Temp at 10 rad/s (c, g)	46 °C			52 °C							58 °C				
Rolling Thin Film Oven (T 240/D 2872)															
Mass Loss, Max. Percent	1.00			1.00							1.00				
Dynamic Shear, T 315/D 7175: G*/sin θ, Min. 2.20 kPa Test Temp at 10 rad/s (g)	46 °C			52 °C							58 °C				
Pressure Aging Vessel Residue (R 28/D 6521)															
PAV Aging Temp (d)	90 °C			90 °C							100 °C				
Dynamic Shear, T 315/D 7175: G*sin θ, Max. 5,000 kPa Test Temp at 10 rad/s, °C (g)	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13
Physical Hardening (e)	Report			Report							Report				
Creep Stiffness, T 313/D 6648: S, Max. 300 MPa, m-value, Min. 0.300 Test Temp at 60 s, °C (f)	−24	−30	−36	0	−6	−12	−18	−24	−30	−36	−6	−12	−18	−24	−30
Direct Tension, T 314/D 6723: Fail. Strain,Min. 1.0% Test Temp at 1.0 mm/min, °C (f)	−24	−30	−36	0	−6	−12	−18	−24	−30	−36	−6	−12	−18	−24	−30

Table 904-2
Performance Graded Asphalt Binder Specification (Continued)

Performance Grade	**PG 64**						**PG 70**					
	−10	−16	−22	−28	−34	−40	>−10	−16	−22	−28	−34	−40
Avg 7 day Max. Pave Design Temp (a)	64 °C						70 °C					
Minimum Pavement Design Temp, °C	−10	−16	−22	−28	−34	−40	−10	−16	−22	−28	−34	−40
Original Binder												
Flash Point Temp, T48/D 92: Min.	230 °C						230 °C					
Viscosity, T 316/D 4402: Max. 3 Pa•s, Test Temp (b)	135 °C						135 °C					
Dynamic Shear, T 315/D 7175: G*/sin θ, Min. 1.00 kPa Test Temp at 10 rad/s (c,g)	64 °C						70 °C					
Rolling Thin Film Oven (T 240/D 2872)												
Mass Loss, Max. Percent	1.00						1.00					
Dynamic Shear, T 315/D 7175: G*/sin θ, Min. 2.20 kPa Test Temp at 10 rad/s (g)	64 °C						70 °C					
Pressure Aging Vessel Residue (R 28/D 6521)												
PAV Aging Temp, °C (d)	100						100 (110)					
Dynamic Shear, T 315/D 7175: G*sin θ, Max. 5,000 kPa Test Temp at 10 rad/s, °C (g)	31	28	25	22	19	16	34	31	28	25	22	19
Physical Hardening (e)	Report						Report					
Creep Stiffness, T 313/D 6648: S, Max. 300 MPa, m-value, Min. 0.300 Test Temp at 60 s, °C (f)	0	−6	−12	−18	−24	−30	0	−6	−12	−18	−24	−30
Direct Tension, T 314/D 6723: Fail. Strain, Min. 1.0% Test Temp at 1.0 mm/min, °C (f)	0	−6	−12	−18	−24	−30	0	−6	−12	−18	−24	−30

Table 904-2
Performance Graded Asphalt Binder Specification (Continued)

Performance Grade	**PG 76**					**PG 82**				
	−10	−16	−22	−28	−34	−10	−16	−22	−28	−34
Avg 7 day Max. Pave Design Temp (a)	76 °C					82 °C				
Minimum Pavement Design Temp, °C	−10	−16	−22	−28	−34	−10	−16	−22	−28	−34
Original Binder										
Flash Point Temp, T 48/D 92: Min.	230 °C					230 °C				
Viscosity, T 316/D 4402: Max. 3 Pa•s, Test Temp (b)	135 °C					135 °C				
Dynamic Shear, T 315/D 7175: G*/sin θ, Min. 1.00 kPa Test Temp at 10 rad/s (c, g)	76 °C					82 °C				
Rolling Thin Film Oven (T 240/D 2872)										
Mass Loss, Max. Percent	1.00					1.00				
Dynamic Shear, T 315/D 7175: G*/sin θ, Min. 2.20 kPa Test Temp at 10 rad/s (g)	76 °C					82 °C				
Pressure Aging Vessel Residue (R 28/D 6521)										
PAV Aging Temp, °C (d)	100 (110)					100 (110)				
Dynamic Shear, T 315/D 7175: G*sin θ, Max. 5000 kPa Test Temp at 10 rad/s, °C (g)	37	34	31	28	22	40	37	34	31	28
Physical Hardening (e)	Report					Report				
Creep Stiffness, T 313/D 6648: S, Max. 300 MPa, m-value, Min. 0.300 Test Temp at 60 s, °C (f)	0	−6	−12	−18	−24	0	−6	−12	−18	−24
Direct Tension, T 314/D 6723: Fail. Strain, Min. 1.0% Test Temp at 1.0 mm/min, °C (f)	0	−6	−12	−18	−24	0	−6	−12	−18	−24

Table 904-2
Performance Graded Asphalt Binder Specification (Continued)

a. Pavement temperatures are estimated from air temperatures using an algorithm contained in the Superpave software program, may be provided by the specifying agency, or by following the procedures as outlined in MP2 and PP28.
b. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.
c. For quality control of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be used or supplement dynamic shear measurements of $G^*/\sin\theta$ at test temperatures where the asphalt is a Newtonian fluid. The Contractor may us a standard means of viscosity measurement, including capillary (T 201/D 2170 or T 202/D 2171) or rotational viscometer (T 316/D 4402).
d. The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures 90%C, 100%C or 110%C. The PAV aging temperature is 100%C for PG 58- and above, except in desert climates, where it is 110%C.
e. Physical Hardening – T 313/D 6648 is performed on a set of asphalt beams according to Section 13.1, except the conditioning time is extended to 24 h ±10 min at 10%C above the minimum performance temperature. The 24 h stiffness and m-value are reported for information purposes only.
f. If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is from 300 MPa to 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.
g. $G^*/\sin\theta$ = high temperature stiffness and $G^*\sin\theta$ = intermediate temperature stiffness.

Table 904-3
Medium and Rapid Curing Cut-Back Asphalts

Tests	Requirements			
	MC-30 (a)	**MC-70** (a)	**MC-250**	**RC-250**
Kinematic Viscosity, 60 °C, mm²/s, T 201/D 2170	30–60	70–140	250–500	250–500
Flash Point, deg °C:				
Tag Open Cup, min, T 79	37.8	37.8	—	26.7
Cleveland Open Cup, min, T 48/D 92	—	—	65.6	—
Distillation Test, T 78/D 402				
Distillate, % by Vol of Total Distillate to 360 °C				
To 225 °C	≤25	≤20	≤10 max	≥35
To 260 °C	40–70	20–60	15–55	≥60
To 315.5 °C	75–93	65–90	60–87	≥80
Residue from Distillation to 360 °C, min	50	55	67	65
Tests on Residue from Distillation, T 78/D 402:				
Penetration at 25 °C, 100 g, 5 sec, T 49/D 5	120–250	120–250	120–250	80–120
Ductility at 25 °C, cm, min T 51/D 113 (b)	100	100	100	100
Solubility in Trichloroethylene, %, min, T 44/D 2042	99.5	99.5	99.5	99.5
Spot Test, AASHTO T 102 (c)	Neg.	Neg.	Neg.	Neg.
Section Number Reference	—	914	—	710, 914

a. Use MC-70 grade from June 1 to September 1 and MC-30 grade other times of the year, unless otherwise directed by the Engineer.
b. If penetration of residue exceeds 200 and ductility, at 25 °C, is less than 100, the Engineer will accept the material if ductility at 15.6 °C exceeds 100.
c. Use 35% Xylene, 65% Heptane solvent, aniline number: 30 °C ±2 °C.

Table 904-4
Anionic Emulsified Asphalts

Anionic Emulsified Asphalts	Requirements						
	RS-1m	**RS-2a**	**HFRS-2**	**MS-Op**	**MS-2h**	**MS-2s**	**SS-1h**
Viscosity, Saybolt Furol, T 59-01/D 7496:							
At 25 °C, sec	20–100	—	—	—	—	—	20–100
At 50 °C, sec	—	50–300	50–300	15–150	50–300	50–300	—
Storage Stability Test, T 59-01/D 6930-04, 24 hr, % Difference max	2	2	2	3	3	3	2
Demulsibility, T 59-01/D 6936-04:							
35 ml 0.02 N $CaCl_2$, %	20–60	≥60	≥40	—	—	—	—
50 ml 0.1 N $CaC1_2$, %	—	—	—	—	—	—	≤2
50 ml 0.02 N $CaCl_2$, %	—	—	—	—	—	—	—
Sieve Test, T 59-01 / D 6933-04, % max	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Miscibility with Water, D 244 (a)	—	—	—	—	—	—	Yes
Distillation to 260°C, T 59-01/D 6997-04, % by Weight:	—	—	—	—	—	—	—
Residue, Min	65	65	65	65	65	65	60
Oil Distillate, max	2	2	2	25	7	7	2
Tests on Distillation Residue:							
Penetration, 25 °C, 100 g, 5 sec, dmm, T 49/D 5	100–200	100–200	100–200	(b)	150–300	≥300	40–90
Float Test, sec, T 50/D 139:							
At 50 °C, max	—	—	—	200	—	—	—
At 60 °C, min	—	—	1,200	—	1,200	1,200	—
Ductility, 25 %C, cm, min, T 51/D 113	60	60	60	40 (b)	—	—	40
Solubility in Trichloroethylene, % min, T 44/D 2042	97.5	97.5	97.5	97.5	97.5	97.5	97.5
Ash Content, %, max, D 128	2	2	2	2	2	2	2
Specific Gravity, 25/25 °C, min., T 228/D 70	0.996	0.996	0.996	—	—	—	—
Toughness/Tenacity, 25 °C, 50 cm/min., Nm, min., D 5801	—	—	—	—	—	—	—
Elastic Recovery, 10 °C, % min., T 301/D 6084	—	—	—	—	—	—	—
Section Number Reference	—	401	—	501	—	501	501, 805

a. No appreciable coagulation or visible separation in 2 hours.
b. Heat the distillation residue (ASTM D 243) to 100±15 penetration within 2 hours, and have a ductility of at least 40 cm.

Table 904-5
Cationic Emulsified Asphalts

Cationic Emulsified Asphalts	Requirements			
	CRS-1	**CRS-2**	**CMS-2**	**CSS-1h**
Viscosity, Saybolt Furol, T 59-01/D 7496:				
At 25 °C, sec	—	—	—	20–100
At 50 °C, sec	20–100	100–400	50–450	—
Storage Stability Tests, T 59-01/D 6930-04, 24 hr, % Difference, max	1	1	1	1
Demulsibility, %, 35 ml 0.8% Dioctyl Sodium Sulfosuccinate, min, T 59-01/D 6936-04, (a)	40	40	—	—
Particle Charge Tests, T 59-01/D 7402 (b)	Positive	Positive	Positive	Positive
Sieve Tests, T 59-01/D 6933-04, % max (Distilled Water)	0.10	0.10	0.10	0.10
Distillation to 260 °C, T 59-01/D 6997-04, % by Weight (c)	—	—	—	—
Residue, min	60	65	65	60
Oil Distillate, max	3	3	12	—
Tests on Distillation Residue:				
Penetration, 25 °C, 100 g, 5 sec, dmm, T 49/D 5	100–250	100–250	100–250	40–90
Ductility, 25 °C, 5 cm/min, cm, min, T 51/D 113	40	40	40	40
Ductility, 4 °C, 5 cm/min, cm, T 51/D 113	—	—	—	—
Elastic/Recovery, 4 °C,% min, T 301/D 6084	—	—	—	—
Solubility in Trichloroethylene, % min, T 44/D 2042	97.5	97.5	97.5	97.5
Ash Content, % max, D 128	2	2	2	2
Specific Gravity, 25/25 °C, min, T 228/D 70	0.996	0.996	—	—
Toughness/Tenacity, 25 °C, 50 cm/min., Nm, min., D 5801	—	—	—	—
Elastic Recovery, 10 °C, % min., T 301/D 6084	—	—	—	—
Cement Mixing Test, T 59-01/D 6935-04, % max	—	—	—	2.0
Coating Ability and Water Resistance:				
Coating Dry Aggregate	—	—	Good	—
Coating After Spraying	—	—	Good	—
Coating Wet Aggregate	—	—	Fair	—
Coating After Spraying	—	—	Fair	—
Section Number Reference	—	—	501	501, 805

a. The Demulsibility Test must be made within 30 days from date of shipment.
b. If Particle Charge Test is inconclusive, material having a maximum pH of 6.7 is acceptable.

Table 904-6
Capital Preventative Maintenance (CPM) Emulsions (h)

	Requirements					
	HFRS-2M	**CRS-2M**	**CSS-1mM**	**CSS-1hM**	**PPSS**	**CSEA**
Viscosity, Saybolt Furol, T 59-01/D 7496:						
At 25 °C, sec	—	—	20–100	20–100	20–100	—
At 50 °C, sec	75–300	75–300	—	—	—	75–400
Storage Stability Test, T 59-01/D 6930-04, 24 hr, % Difference max	1	1	1	1	1 (g)	1
Demulsibility, T 59-01/D 6936-04:						
35 ml 0.8% Dioctyl Sodium Sulfosuccinate, % min (a)	—	50	—	—	60	50
35 ml 0.02 N $CaCl_2$, %, min.	—	—	—	—	60	—
50 ml 0.1 N $CaC1_2$, %	—	—	—	—	—	—
50 ml 0.02 N $CaCl_2$, %	≥50	—	—	—	—	—
Particle Charge Tests, T 59-01/D 7402 (b)		Positive	Positive	Positive	—	Positive
Sieve Test, T 59-01 / D 6933-04, % max	0.10	0.10	0.10	0.10	0.05	0.10
Miscibility with Water, D 244 (f)	—	—	—	—	—	—
Distillation to 260°C, T 59-01/D 6997-04, % by Weight:	(e)	(e)(j)	(e)	(e)	(e)	(i)
Residue, Min	65	65	62	62	63	68
Oil Distillate, ml, max, D 244	2	3	—	—	2	3.0
Tests on Distillation Residue:						
Penetration, 25 °C, 100 g, 5 sec, dmm, T 49/D 5	80–150	80–150	70–90	40–90	80–150	70–100
Ductility, 25 °C, 5 cm/min, cm, T 51/D 113	—	—	40	40	—	40
Ductility, 4 °C, 5 cm/min, cm, T 51/D 113	—	—	35	—	—	—
Elastic/Recovery, 4 °C,% min, T 301/D 6084	—	—	65	—	—	—
Float Test, sec, T 50/D 139:						
At 50 °C, max	—	—	—	—	—	—
At 60 °C, min	1,200	—	—	—	—	—
Solubility in Trichloroethylene, % min, T 44/D 2042	—	—	97.5	97.5	—	97.5
Ash Content, %, max, D 128	2	2	2	2	—	2
Specific Gravity, 25/25 °C, min., T 228/D 70	—	—	—	—	—	—
Toughness/Tenacity, 25 °C, 50 cm/min., Nm, min., D 5801	4.5/3.5	4.5/3.5	—	—	—	9.0/7.0
Elastic Recovery, 10 °C, % min., T 301/D 6084	60%	60%	—	—	60	75
Tests on Residue from Evaporation, T 59-01/D 6934-04: (c)						
Softening Point, Ring & Ball, °C, min., T 53/D 36	—	—	60	57.2	—	—
Viscosity, 60C, Pa•S, T 202/D 2171	—	—	800 (d)	800 (d)	—	—
Section Number Reference	505	505	507	507	—	—

a. The Demulsibility Test must be made within 30 days from date of shipment.
b. If Particle Charge Test is inconclusive, material having a maximum pH of 6.7 is acceptable.
c. Residue by evaporation: Oven evaporate an emulsion sample on a glass plate at a maximum temperature of 60 °C for 24 hours (forced draft oven recommended) or air dry the sample at ambient temperature for three days. Once dry, the sample is scraped from the plate using a razor blade tool.
d. The minimum Viscosity will be obtained using a Cannon-Manning Vacuum Capillary Viscometer Tube No. 14 per T 202 / D 2171.
e. ASTM D 6997, with modifications to include a 204 °C (± 6 °C) maximum temperature to be held for 15 minutes.
f. No appreciable coagulation or visible separation in 2 hours.
g. After standing undisturbed for 24 hours, the surface must show no white, milky colored substance, but must be a smooth homogenous color throughout. Any visible amount of white, milky colored substance is basis for non-acceptance.
h. Samples of emulsified asphalt will be taken in accordance with ASTM D 140. Samples must be stored at a temperature of not less than 4 °C until tested.
i. Residue determination and preparation may use the alternate ASTM D 6934 method, “Residue by Evaporation” so as to not destroy the properties of any polymer modifiers contained therein.

Table 904-7 Temperatures for Asphaltic Materials		
Asphalt Type	**Designation**	**Temperature, °F Distributor**
Cut-Back Asphalts	RC-250	145–220
	MC-250	145–220
	MC-30	70–140
	MC-70	105–180
Emulsified	RS-1m, SS-1h, CSSmM, CRS-1, CSS-1h, CSS-1hM,	85–135
Asphalts	RS-2a, HFRS-2, HFRS-2M, MS-2h, MS-2s, CRS-2, CMS-2, CRS-2M	125–175
Asphalt Binder	All Grades	350 Maximum Mixing Temp (a)
a. Mixing temperature for all asphalt binders will be as specified by the modifier/binder producer.		