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SECTION 210--ASPHALT MATERIALS

210.01--Description.

These specifications cover asphalt material consisting of asphalt, asphalt cement, asphalt cutback, or asphalt emulsion as defined in ASTM D8.

- (a) **ASPHALT CEMENTS** – Whenever and wherever within the Contract documents asphalt cements are specified, they shall be defined as Strategic Highway Research Project (SHRP) Performance Graded (PG) asphalt cements. Substitution of AASHTO designated asphalt cements with performance graded asphalt cements shall be in accordance with the following:

AASHTO DESIGNATION	SHRP DESIGNATION PERFORMANCE GRADED *
AC-5	PG-52-28
AC-10	PG-58-22
AC-20	PG-64-22
AC-30	PG-70-22
AC-40	PG-70-22

* PG asphalts shall conform to the requirements of AASHTO Provisional Specifications MP-1.

210.02--Materials.

Asphalt material shall be homogeneous and shall conform to the following:

1. Rapid curing and medium curing liquid asphalts used as surface treatments shall contain a heat-stable additive conforming to the requirements of Section 211.
2. Liquid asphalt material will be tested for coating ability in accordance with the requirements of AASHTO T182, with the following modifications:
 - a. Material that can coat 95 percent of a shady dolomite will be classified Type I.
 - b. Material that can coat 95 percent of a siliceous gravel wetted with 2 percent water by weight will be classified Type II.
3. Rapid curing cutback asphalts shall conform to the requirements of AASHTO M81.
4. Medium curing cutback asphalts shall conform to the requirements of AASHTO M82.
5. Cements shall be viscosity graded conforming to AASHTO M226, Table 2, except that the loss on heating shall be not greater than 1.0 for AC-5, 0.8 for AC-20 and 0.5 for all other grades.
6. Emulsions shall conform to the requirements of AASHTO M208 and shall be Type I as specified in 2.a. herein except that CRS-2 shall be Type II as specified herein. CRS-1h shall conform to the requirements of AASHTO M208 for CRS-1 except that the penetration shall be 40 to 110. Emulsions will be sampled and tested in accordance with the requirements of AASHTO T59 except that viscosity will be tested in accordance with the requirements of VTM-64.

210.03--Detail Requirements.

- (a) **Shipping:** Shipments of asphalt material shall be made in transporting media that are free from contamination. Tank trucks or trailers shall be equipped with a sampling device approved by the Engineer. The device shall have an inside diameter of 1/2 to 1 inch and a gate valve or petcock. The device shall be built into the tank or the recirculating or discharge line so that a sample can be drawn during circulation or discharge.
- (b) **Storing:** Asphalt material to be stored shall be placed in storage tanks that are free from contamination.

210.04--Payment Adjustment System-

If the material represented by any one sample does not conform to the requirements herein and the material is a pay item, the contract unit price for the item will be reduced by 4 percent for each property that does not conform to the specifications for the quantity represented by the sample that was used on the project. Unused material represented by the failing sample will be rejected.

If the material represented by a failing sample was nor a pay item, the material will be considered unacceptable and shall be subject to the requirements of Sections 105.13 and 106.10.

SECTION 211 ASPHALT CONCRETE MIXTURES (SUPERPAVE) (Feb 9, 2010)

211.01 -- Description - Asphalt concrete shall consist of a combination of mineral aggregate and asphalt material mixed mechanically in a plant specifically designed for such purpose.

An equivalent single axle load (ESAL) will be established by the Engineer, and SUPERPAVE mix types may be specified as one of the types listed as follows:

Mix Type	Equivalent Single-Axle Load (ESAL) Range (millions)	Asphalt Performance Grade (PG)²	Aggregate Nominal Maximum Sieve in.¹
SM-9.0 A	0 to 3	64-16	3/8 in
SM-9.0 D	3 to 10	70-16	3/8 in
SM-9.0 E	Above 10	76-22	3/8 in
SM-9.5 A	0 to 3	64-16	3/8 in
SM-9.5 D	3 to 10	70-16	3/8 in
SM-9.5 E	Above 10	76-22	3/8 in
SM-12.5 A	0 to 3	64-16	1/2 in
SM-12.5 D	3 to 10	70-16	1/2 in
SM-12.5 E	Above 10	76-22	1/2 in
IM-19.0 A	Less than 10	64-16	3/4 in
IM-19.0 D	10 to 20	70-16	3/4 in
IM-19.0 E	20 and above	76-22	3/4 in
BM-25.0 A	All ranges	64-16	1 in
BM-25.0 D	Above 10	70-16	1 in

¹ **Nominal Maximum Size** is defined as one sieve size larger than the first sieve to retain more than 10 percent aggregate.

² **Minimum Asphalt Performance Grade(PG)** is defined as teh minimum binder performance grade for the job mixes as determined by AASHTO T170 or AASHTO M320.

Asphalt concrete shall conform to the requirements for the mix type designated.

At the Contrato's optin, Warm mix Asphalt Asphalt (WMA) additive or process may be usd in leiu of the appropriate Ht Mix asphalt

211.02 – Materials-

- (a) **Asphalt materials** shall conform to the requirements of Section 210 except asphalt cement materials shall be performance graded (PG) in accordance with the requirements of AASHTO M320. In addition, asphalt mixtures with the E designation shall meet the asphalt cement requirements in Section 211.04(e)1.
- (b) **Coarse aggregate** shall be Grade A or B, conforming to the requirements, except for grading, of Section 203 for quality. In addition, the coarse aggregate sizes retained on and above the No. 4 sieve shall comply with the coarse aggregate requirements in Table II-12A. Flat and elongated (F&E) particles shall be tested in accordance with the requirements of ASTM D 4791, and

coarse aggregate angularity (CAA) shall be tested on crushed gravel only in accordance with the requirements of ASTM D 5821.

- (c) **Fine aggregate** shall conform to the requirements except for grading of Section 202 for quality and the fine aggregate requirements in Table II-12A. Fine aggregate angularity (FAA) shall be tested in accordance with the requirements of AASHTO T 304 (Method A) and sand equivalent (SE) shall be tested in accordance with the requirements of AASHTO T 176.
- (d) After a gradation is performed:
1. If 10 percent or more of the material is retained on the No. 4 sieve, that portion will be tested in accordance with the requirements for coarse aggregates.
 2. If 10 percent or more of the material passes the No. 4 sieve, that portion will be tested for SE.
 3. If 10 percent or more of the material passes the No. 8 sieve, that portion will be tested for FAA.
- (e) Fine or coarse aggregates that tend to polish under traffic will not be permitted in any final surface exposed to traffic except in areas where the two-way average daily traffic is less than 750 vehicles per day and as permitted elsewhere in these specifications.

**TABLE II-12A
AGGREGATE PROPERTIES**

Mix Type	Coarse Aggregate Properties		A STM D4791 F & E "(5:1) Percent by weight	Fine Aggregate Properties	
	CAA			SE	FAA
	1 fractured Face	2 fractured Faces			
SM-9.0 A	85% min.	80% min.	10% Max ¹	40% min.	40% min.
SM-9.0 D	85% min.	80% min.	10% Max ¹	45% min.	45% min.
SM-9.0 E	95% min.	90% min.	10% Max ¹	45% min.	45% min.
SM-9.5 A	85% min.	80% min.	10% Max ¹	45% min.	45% min.
SM-9.5 D	85% min.	80% min.	10% Max ¹	45% min.	45% min.
SM-9.5 E	95% min.	90% min.	10% Max ¹	45% min.	45% min.
SM-12.5 A	85% min.	80% min.	10% Max ¹	45% min.	45% min.
SM-12.5 D	85% min.	80% min.	10% Max ¹	45% min.	45% min.
SM-12.5 E	95% min.	90% min.	10% Max ¹	45% min.	45% min.
IM-19.0 A	85% min.	80% min.	10% Max ¹	45% min.	45% min.
IM-19.0 D	95% min.	90% min.	10% Max ¹	45% min.	45% min.
IM-19.0 E	95% min.	90% min.	10% Max ¹	45% min.	45% min.
BM-25.0 A	80% min.	75% min.	10% Max ¹	45% min.	45% min.
BM-25.0 D	80% min.	75% min.	10% Max ¹	45% min.	45% min.

¹ 10 percent measured at 5:1 on maximum to minimum dimension.

- (f) Mineral filler shall conform to the requirements of Section 201.
- (g) Aggregate for asphalt concrete shall be provided in sufficient sizes to produce a uniform mixture. The Contractor shall indicate on the proposed job-mix formula the separate approximate sizes of aggregate to be used. Where segregation or nonuniformity is evident in the finished pavement, the Engineer reserves the right to require the Contractor to discontinue the use of crusher run or aggregate blends and to furnish separate sizes of open graded aggregate material.

- (h) An antistripping additive shall be used in all asphalt mixes. It may be hydrated lime or an approved chemical additive from the Department's approved list found in the Materials Division's Manual of Instructions, or a combination of both.

The mixture shall produce a tensile strength ratio (TSR) value not less than 0.80 for the design and production tests. The TSR value shall be determined in accordance with AASHTO T283, including a freeze-thaw cycle, (4 inch specimens compacted with Marshall hammer or 3.5 x 6 inch specimens when compacted with a gyratory), except that the 16 hour curing time requirement and 72 to 96 hour storage period will be waived. Design tests shall use the same materials that are to be used in the production mix and shall be conducted in a laboratory approved by the Department. When Warm Mix Asphalt (WMA) additive or process, as described in 211.02(i) of the Specifications, is used in lieu of Hot Mix Asphalt (HMA) in the production of asphalt concrete, the minimum TSR requirement shall be 0.80 for the design and production tests.

When a chemical additive is used, it shall be added to the asphalt cement prior to introduction into the mix. Any chemical additive or particular concentration of chemical additive found to be harmful to the asphalt material or which changes the viscosity of the original asphalt cement more than 400 poises or the penetration more than -4 or +10 shall be changed to obtain compliance with these values.

- (i) **Hydrated lime** shall conform to the requirements of ASTM C977. Hydrated lime shall be added at a rate of not less than 1 percent by weight of the total dry aggregate.

A separate bin or tank and feeder system shall be provided to store and accurately proportion the lime into the aggregate in either dry or slurry form. The lime and aggregate shall be mixed by pugmill or other approved means to achieve a uniform lime coating of the aggregate prior to entering the drier. In the event lime is added in dry form, the aggregate shall contain at least 3 percent free moisture. The stockpiling of lime treated aggregate will not be permitted.

The feeder system shall be controlled by a proportioning device, which shall be accurate to within \pm 10 percent of the specified amount. The proportioning device shall have a convenient and accurate means of calibration. A flow indicator or sensor shall be provided with the proportioning device and interlocked with the plant controls, aggregate feed or weigh system, such that production of the mixture will be maintained and, if there is a stoppage of the lime feed, interrupted.

The method of introducing and mixing the lime and aggregate shall be subject to approval by the Engineer prior to beginning production.

- (j) **Reclaimed Asphalt Pavement (RAP)** material may be used as a component material of asphalt mixtures in conformance with the following:

1. Asphalt surface, intermediate, and base mixtures containing RAP should use the performance grade (PG) of asphalt cement as indicated in Table II-14, however, the choice of PG to use in the mix shall be the responsibility of the Contractor in order to meet the requirements of Section 211.01
2. The final asphalt mixture shall conform to the requirements for the type specified.
3. During the production process, RAP material shall not be allowed to contact open flame.
4. RAP material shall be handled, hauled and stored in a manner that will minimize contamination. Further, the material shall be stockpiled and used in such manner that variable asphalt contents and asphalt penetration values will not adversely affect the consistency of the mixture.
5. RAP shall be processed in such a manner as to ensure that the maximum top size introduced into the mix shall be 2 inches. The Engineer may require smaller sized particles be introduced into the mix if the reclaimed particles are not broken down or uniformly distributed throughout the mixture during heating and mixing.

- (k) **Warm Mix Asphalt (WMA)** additives or processes shall be approved by the Department prior to use. Approved materials and processes shall be obtained from the Department's approved list which is included in the Materials Division's Manual of Instructions.

211.03 – Job-Mix Formula - The Contractor shall submit for the Engineer's approval a job-mix formula for each mixture to be supplied. The job-mix formula shall be within the design range specified. The job-mix formula shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt material to be added to the aggregate, a temperature at which the mixture is to be produced, and a temperature at which the mixture is to be compacted for SUPERPAVE testing in accordance with the requirements of AASHTO R35. Each approved job-mix formula shall remain in effect, provided the results of tests performed on material currently being produced consistently comply with the requirements of the job-mix formula for grading, asphalt content, temperature, and SUPERPAVE compaction results and the requirements of Section 315.

- (a) SUPERPAVE mixes shall be designed and controlled in accordance with the requirements of AASHTO R35 and as specified herein. The Contractor shall have available all of the equipment outlined in AASHTO T312 (section 4-6) and a Department-certified Asphalt Mix Design Technician. The SUPERPAVE mixture shall be compacted in a gyratory compactor with an internal angle of 1.16 + 0.02 degrees. The internal angle shall be measured and calibrated using a cold (non-mix) device. The SUPERPAVE Gyratory Compactor (SGC) shall be one from the Department's approved list found in the Materials Division's Manual of Instructions. The SUPERPAVE mixes shall conform to the requirements of Table II-13 and Table II-14. Section 7.1.2 of AASHTO R30 shall be modified such that the compaction temperature is as specified in (d) 6 herein.

The mixture shall be designed and compacted at the N design gyrations specified in Table II-14. The N Max. requirement shall be verified as part of the design process by compacting a minimum of two specimens at the design asphalt content.

- (b) In conjunction with the submittal of a job-mix formula, the Contractor shall submit complete SUPERPAVE design test data, ignition furnace calibration data in accordance with VTM-102 prepared by an approved testing laboratory, and viscosity data or supplier temperature recommendations for the asphalt cement if different from (d) 6 herein.

- (c) Three trial blends for gradation shall be run at one asphalt content.

TABLE II - 13
Asphalt Concrete Mixtures: Design Range¹
Percentage by Weight Passing Square Mesh Sieves

Mix Type	2 in	1 1/2 in	1 in	3/4 in	1/2 in	3/8 in	No. 4	No. 8	No. 30	No. 50	No. 200
SM-9.0 A,D,E					100 ²	90-100	90 max	47-67			2-10
SM-9.5 A,D,E					100 ²	90-100	80 max.	38-67			2-10
SM-12.5 A,D,E				100	95-100	90 max	--	34-50			2-10
IM-19.0 A,D, E			100	90 - 100	90 max	--	--	28-49			2-8
BM-25.0 A, D		100	90-100	90 max	--	--	--	19-38			1-7
C (Curb Mix)					100	92-100	70-75	50-60	28-36	15-20	7-9

¹ SM = Surface Mix; IM = Intermediate Mix; BM = Base Mix; C = Curb Mixture

² A production tolerance of 1% will be applied to this sieve, regardless of the number of tests in the lot.

**TABLE II-14
Mix Design Criteria**

Mix Type	VTM (%) Production (Note 1)	VFA (%) Design	VFA (%) Production (Note 2)	Min. VMA (%)	Fines/Asphalt Ratio (Note 3)	No. of Gyration			Density (%) at N Initial
						N Design	N Initial	N Max	
SM-9.0 A ^{Notes 1,2,3}	2.0-5.0	75-80	70-85	16	0.6-1.3	65	7	100	≤ 90.5
SM-9.0 D ^{Notes 1,2,3}	2.0-5.0	75-80	70-85	16	0.6-1.3	65	7	100	≤ 89.0
SM-9.0 E ^{Notes 1,2,3}	2.0-5.0	75-80	70-85	16	0.6-1.3	65	7	100	≤ 89.0
SM-9.5 A ^{Notes 1,2,3}	2.0-5.0	73-79	68-84	15	0.6-1.2	65	7	100	≤ 90.5
SM-9.5 D ^{Notes 1,2,3}	2.0-5.0	73-79	68-84	15	0.6-1.2	65	7	100	≤ 89.0
SM-9.5 E ^{Notes 1,2,3}	2.0-5.0	73-79	68-84	15	0.6-1.2	65	7	100	≤ 89.0
SM-12.5 A ^{Notes 1,2,3}	2.0-5.0	70-78	65-83	14	0.6-1.2	65	7	100	≤ 90.5
SM-12.5 D ^{Notes 1,2,3}	2.0-5.0	70-78	65-83	14	0.6-1.2	65	7	100	≤ 89.0
SM-12.5 E ^{Notes 1,2,3}	2.0-5.0	70-78	65-83	14	0.6-1.2	65	7	100	≤ 89.0
IM-19.0 A ^{Notes 1,2,3}	2.0-5.0	69-76	64-81	13	0.6-1.2	65	7	100	≤ 90.5
IM-19.0 D ^{Notes 1,2,3}	2.0-5.0	69-76	64-81	13	0.6-1.2	65	7	100	≤ 89.0
IM-19.0 E ^{Notes 1,2,3}	2.0-5.0	69-76	64-81	13	0.6-1.2	65	7	100	≤ 89.0
BM-25.0 A ^{Note 2, 3, 4}	1.0-4.0	67-87	67-92	12	0.6-1.3	65	7	100	≤ 89.0
BM-25.0 D ^{Note 2, 3, 4}	1.0-4.0	67-87	67-92	12	0.6-1.3	65	7	100	≤ 89.0

¹ SM = Surface Mix; IM = Intermediate Mixture; BM = Base Mixture

Note 1: Asphalt content should be selected at 4.0 % Air Voids.

Note 2: During production of an approved job mix, the VFA shall be controlled within these limits.

Note 3: Fines-Asphalt Ratio is based on effective asphalt content.

Note 4: Base mix shall be designed at 2.5 percent air voids. BM-25.0 A shall have a minimum asphalt content of 4.4 percent, unless otherwise approved by the Engineer. BM-25.0 D shall have a minimum asphalt content of 4.6 percent, unless otherwise approved by the Engineer.

- d) The SUPERPAVE design test data shall include but not be limited to the following information:
1. Grading data for each aggregate component of 3 trial blends shall be submitted to the Department. The data for the mixture will show percent passing for sieves 2 inch, 1 1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100 and No. 200. The grading shall be reported to the nearest 1.0 percent except the No. 200 sieve shall be reported to nearest 0.1 percent.
 2. The test data shall include, but not be limited to, the percentage of each aggregate component as compared to the total aggregate in the asphalt mixture. The specific gravity and aggregate properties for coarse and fine aggregates defined in Section 211.02 (b) and (c), including flat and elongated properties, for each aggregate component or for the total aggregates used in the mixture shall be reported. Aggregate properties, except sand equivalent shall be reported for RAP portions of a mixture. The aggregate specific gravity of RAP shall be the effective aggregate specific gravity calculated from the results of tests conducted in accordance with AASHTO T 209 and VTM 102.
 3. The aggregate grading in the asphalt mixture shall be determined by igniting or extracting the asphalt from a laboratory prepared sample. The laboratory sample shall be batched on the basis of component percentages as indicated in (d) 2. herein and at the proposed job-mix asphalt content. The aggregate shall be obtained in accordance with the requirements of VTM-102 or (VTM-36 when approved). Sieves specified in (d) 1. herein shall be reported, beginning with the top size for the mix.

4. The following volumetric properties of the compacted mixture, calculated on the basis of the mixture's maximum specific gravity determined by AASHTO T-209 shall be reported to the Engineer. The mixture must be aged in accordance with AASHTO R-30 and the bulk specific gravity of the specimens determined in accordance with AASHTO T-166, Method A, for each asphalt content tested. Properties shall be determined and reported in accordance with the requirements of AASHTO R35.
 - a. Voids in total mix (VTM)
 - b. Voids in mineral aggregate (VMA)
 - c. Voids filled with Asphalt (VFA)
 - d. Fines/Asphalt ratio (F/A)
 5. The value of the maximum specific gravity of the asphalt mixture used in (c) 4. herein shall be reported to three decimal places.
 6. The mixing and compaction temperature for testing shall be as follows:
 - a. Formix designation A, the mix temperature shall be 300°F to 310°F and the compaction temperature shall be 285 °F to 290°F.
 - b. Formix designation D, the mix temperature shall be 310°F to 320°F and the compaction temperature shall be 295 °F to 300 °F.
 - c. In cases involving PG 76-22 or modified binders, the temperatures shall be based on documented supplier's recommendations.
 7. The field correction factor as determined by subtracting the bulk specific gravity of the aggregate from the effective specific gravity of the aggregate at the design asphalt content.
 8. For surface mixes, permeability test data shall be submitted in accordance with VTM-120 using either single point verification or the regression method for each surface mix having a different gradation. If the average if the permeability results from the single point verification method exceeds 150×10^{-5} cm/sec, or if the regression method predicts a permeability exceeding 150×10^{-5} cm/sec at 7.5% voids, the Contractor shall redesign the mixture to produce a permeability number less than 150×10^{-5} cm/sec.
- (e) The SUPERPAVE design test data shall be plotted on graphs as described in AASHTO R35 and show that the proposed job-mix formula conforms to the requirements of the mix type.
- (f) A determination will be made that any asphalt concrete mixture being produced conforms to the job-mix formula approved by the Department. The Department and Contractor will test the mixture using samples removed from production. The following tests will be run to determine the properties listed:

Property	Test
Asphalt content	VTM-102, (VTM-36 when approved)
Gradation	AASHTO T-30
SUPERPAVE properties	AASHTO R35
Asphalt cement material	AASHTO T316 or T-201

For Warm Mix Asphalt (WMA), SUPERPAVE properties will be determined by the Department and Contractor once the WMA has been allowed to cool to 100 degrees F or less and reheated based on the mix designation in Section 211.03 (d) 6 of the Specifications.

The Department will perform rut testing in accordance with the procedures detailed in VTM-110. If the results of the rut testing do not conform to the following requirements, the Engineer reserves the right to require adjustments to the job-mix formula:

<u>Mix Designation</u>	<u>Maximum Rut Depth, mm</u>
A	7.0
D	5.5
E, (M), (S)	3.5

After calibration of the gyratory compactor is completed, adjustments to the job-mix formula may be required by the Engineer.

In the event the Department determines that the mixture being produced does not conform to the approved job-mix formula and volumetric properties specified in Table II-14 based on the Department's or Contractor's test results, the Contractor shall immediately make corrections to bring the mixture into conformance with the approved job-mix formula or cease paving with that mixture.

Subsequent paving operations, using either a revised or other job-mix formula which has not been verified as described herein, shall be limited to a test run of 100 to 300 tons of mixture if such material is to be placed in Department project work. No further paving for the Department using that specific mixture shall occur until the acceptability of the mixture being produced has been verified using the 100 to 300 ton constraint.

TABLE II-14A
Recommended Performance Grade of Asphalt Cement

<u>Mix Type</u>	<u>Percentage of Reclaimed Asphalt Pavement (RAP) in Mix</u>		
	<u>% RAP ≤ 20.0</u>	<u>20.0% < % RAP ≤ 30%</u>	<u>20.0% < %RAP ≤ 35%</u>
SM-9.0A, SM-9.5A, SM-12.5A	PG 64-22	PG 64-22	
SM-9.0D, SM-9.5D, SM-12.5D	PG 70-22	PG 64-22	
IM-19.0A	PG 64-22	PG 64-22	
IM-19.0D	PG 70-22	PG 64-22	
BM-25.0A	Pg-64-22		PG 64-22
BM-25.0D	PG 70-22		PG 64-22

Based on rut testing performed by th Department and/ or field performance of the job-mix, the Engineer reserves the right to require adjustments to the job-mix formula.

211.04 -- Asphalt concrete mixtures

Asphalt concrete mixtures shall conform to the requirements of Table II-14 and the following:

- (a) **Types SM-9.0A, SM-9.0D, SM-9.0E, SM-9.5A, SM-9.5D, SM-9.5E, SM-12.5A, SM-12.5D, and SM-12.5E asphalt concrete** shall consist of crushed stone, crushed slag, or crushed gravel and fine aggregate, slag or stone screenings or a combination thereof combined with asphalt cement.

NOTE: For all surface mixes, except where otherwise noted, no more than 5 percent of the aggregate retained on the No. 4 sieve and no more than 20 percent of the total aggregate may be polish susceptible. At the discretion of the Engineer, a SM-9.5AL or SM-12.5AL may be specified and polish susceptible aggregates may be used (without percentage limits).

- (b) **Types IM-19.0A and IM-19.0D and Im-19.0E asphalt concrete** shall consist of crushed stone, crushed slag, or crushed gravel and fine aggregate, slag or stone screenings or a combination thereof combined with asphalt cement.

NOTE: At the discretion of the Engineer, an intermediate mix may be designated as either a SM-19.0A or SM-19.0D. When designated as such, no more than 5 percent of the aggregate retained on the No. 4 sieve may be polish susceptible. All material passing the No. 4 sieve may be polish susceptible.

- (c) **Types BM-25.0A and BM-25.0D asphalt concrete** shall consist of crushed stone, crushed slag, or crushed gravel and fine aggregate, slag or stone screenings or a combination thereof combined with asphalt cement.
- (d) **Type C (Curb Mix) asphalt concrete** shall consist of a blend of No. 78 or No. 8 crushed aggregate, No. 10 crushed aggregate, fine aggregate, mineral filler and a stabilizing additive from the Department's approved list found in the Materials Division's Manual of Instructions combined with 6.0 – 9.0 percent of PG 64-22. This mix does not require a volumetric mix design or volumetric testing under the Superpave system.
- (e) **Type SM-9.5, SM-12.5, IM-19.0, BM-25.0 asphalt concrete** may be designated E (polymer modified), or stabilized (S) Asphalt mixtures with the E designation may not be stabilized.
 - 1. **Type E asphalt mixtures** shall consist of mixes incorporating a neat asphalt material with polymer modification meeting the requirements of a PG 76-22 and have a rolling thin film oven test residue elastic recovery at 77°F of a minimum 70 percent when tested in accordance with ASTM D 6084 procedure A. E designated mixtures shall not contain more than 15 percent reclaimed asphalt pavement (RAP) material.
 - 2. **Type (S) asphalt mixtures** shall consist of mixes incorporating a stabilizing additive from the Department's approved list found in the Materials Division's Manual of Instructions. These mixes shall be designated with an (S) following the standard mix designation. The minimum required additive shall be as specified on the Department's approved list found in the Materials Division's Manual of Instructions.
 - 3. **Type L asphalt mixtures** will be allowed to contain a 100 percent polishing coarse and fine aggregate. These mixes shall be designated with an L following the standard mix designation.

211.05 -- Testing - The Contractor shall provide the quality control and assurance necessary for the Department to determine conformance with the required grading, asphalt content and temperature properties for asphalt concrete.

The Contractor shall have a Department- certified Asphalt Mix Design Technician for designing and adjusting mixes as necessary. The Asphalt Mix Design Technician or certified Asphalt Plant Technician may perform testing of asphalt mixes. The Asphalt Mix Design Technician shall be responsible for reviewing and approving the results of all testing. The Asphalt Mix Design Technician shall be available and have direct communication with the plant for making necessary adjustments in the asphalt concrete mixes at the mixing plant. The Asphalt Mix Design Technician and Asphalt Plant Technician shall be capable of conducting any tests necessary to put the plant into operation, however, it shall be the responsibility of the Asphalt Mix Design Technician to produce a mixture within the requirements of these specifications. The Department will award certification.

The Contractor shall maintain all records and test results associated with the material production and shall maintain appropriate current quality control charts. All test results and control charts shall be available for review by the Engineer.

The Contractor shall execute a quality control plan of process inspections and tests, including the determination of SUPERPAVE properties. The results of the SUPERPAVE tests shall be used, along with the results of other quality control efforts, to control the quality of the mixture being produced.

The Contractor shall perform at least one field SUPERPAVE test per day per mix or per 1000 tons per mix if more than 1000 tons of a mix is produced per day. Aging as described in AASHTO R30 shall not be performed. In the event less than 300 tons of asphalt mixture is produced under a single job-mix formula in a day, field SUPERPAVE testing will not be required. This tonnage shall be added to subsequent

production. When the accumulated tonnage exceeds 300 tons, minimum testing frequency shall apply. Field SUPERPAVE test results shall be plotted and displayed in control chart form in the plant immediately following the completion of each individual test. The tests shall determine asphalt content, VTM, VMA, VFA and F/A in percent to the nearest 0.1 percent. The Department will conduct on-site inspections so the Contractor's Asphalt Mix Design Technician can demonstrate a knowledge of the SUPERPAVE mix design and production requirements on Department-supplied mixture.

Aggregate specific gravity and aggregate property tests shall be conducted by a VDOT certified Aggregate Properties Technician or Asphalt Mix Design Technician on each aggregate component (including RAP) or total aggregate mixture once at design and once prior to beginning production in each calendar year. Sand Equivalent shall not be determined on RAP. In addition, for each 50,000 tons of each aggregate size used at each plant, aggregate specific gravity and aggregate property test shall be reported on each aggregate component or the total aggregate mixture. Otherwise, if the total blend (cold feed) is used to determine aggregate specific gravity and aggregate properties, these tests shall be run for each 50,000 tons of the total blend.

Field Superpave tests shall be performed to N_{design} gyrations as specified in Table II-14. At the Engineer's discretion, the N_{max} requirement may be verified.

211.06 - Tests

The Department may sample materials entering into the composition of the asphalt concrete, the mixture or the completed pavement. The Contractor shall cooperate with the Engineer in obtaining these samples. When samples are obtained from the pavement, the resulting voids shall be filled and refinished by the Contractor without additional compensation.

Abson recovery samples shall be PG graded according to the requirements of AASHTO M 320-05. Samples meeting the required grades specified in Section 211.01 of the Specifications shall be acceptable.

When the Department performs PG grading on the asphalt in a Contractor's liquid asphalt storage tank, the Engineer will notify the asphalt concrete producer and binder supplier if tests indicate that the binder properties of the asphalt material differ from those of the approved job-mix. The asphalt concrete producer and binder supplier shall determine corrective action with the approval of the Engineer.

211.07 -- Plant inspections

The preparation of asphalt concrete mixtures will be accepted under a quality assurance plan. The Contractor shall provide a laboratory as specified in Section 106.07.

In addition, the Contractor shall have all laboratory scales and gyratory compactors calibrated once a year by an independent source. The Contractor shall maintain the calibration records for 3 years.

211.08 -- Acceptance

Acceptance will be made under the Department's quality assurance program which includes the testing of production samples by the Contractor and of monitor samples by the Department. Sampling and testing for the determination of grading, asphalt cement content and temperature shall be performed by the Contractor, and the Department will perform independent monitor checks at a laboratory of its discretion. The Contractor shall provide copies of such test results to the Department on forms furnished by the Department. Where the Contractor's test results indicate that the mixture conforms to the gradation, asphalt cement content and mix temperature requirements of the Specifications, the mixture will be acceptable for these properties; however, nothing herein shall be construed as waiving the requirements of Sections 106.06, 200.02 and 200.03, and 315 or relieving the Contractor of the obligation to furnish and install a finished functional product which conforms to the requirements of the Contract.

In the event a statistical comparative analysis of the Contractor's test results and the Department's monitor tests indicate a statistically significant difference in the results and either of the results indicate that the material does not conform to the grading and asphalt cement content requirements of the Specifications, an investigation will be made to determine the reason for the difference. In the event it is determined from the investigation that the material does not conform to the requirements of the Contract, price adjustments will be made in accordance with the requirements of Section 211.09.

Acceptance for gradation and asphalt cement content will be based on the mean of results of eight tests performed on samples taken in a stratified random manner from each 4,000 ton lot (8,000 ton lots may be used when the normal daily production of the source from which the material is being obtained is in excess of 4,000 tons). Unless otherwise approved by the Engineer, samples shall be obtained from the approximate center of the truckload of material. Any statistically acceptable method of randomization may be used to determine when to take the stratified random sample; however, the Department shall be advised of the method to be used prior to beginning production.

A lot will be considered to be acceptable for gradation and asphalt content if the mean of the test results obtained is within the tolerance allowed from the job-mix formula, as shown in Table II-15.

The temperature of the mixture at the plant shall be controlled to provide load-to-load uniformity during changing weather conditions and surface temperatures. The maximum temperature of mix designations A and D, and base mixes, shall not exceed 350° F, unless otherwise directed by the Engineer. The maximum temperature as recommended by the supplier shall not be exceeded for a mix designated E, (M), or (S) .

In the event the job-mix formula is modified within a lot, the mean test results of the samples taken will be compared to the applicable process tolerance shown in Table II-15.

Asphalt content will be measured as extractable asphalt or weigh after ignition.

Field SUPERPAVE tests will be performed by the Department in accordance with the requirements of AASHTO R35 during the production of the approved job-mixes designed by the SUPERPAVE method. Aging, as described in AASHTO R30, shall not be performed. Should any field SUPERPAVE test fail with regard to the limits specified in Table II-14, the Department may require that production be stopped until necessary corrective action is taken by the Contractor. The Engineer will investigate and determine the acceptability of material placed and represented by failing field SUPERPAVE test results.

Should visual examination by the Engineer reveal that the material in any load or portion of the paved roadway is obviously contaminated or segregated, that load or portion of the paved roadway will be rejected without additional sampling or testing of the lot. In the event it is necessary to determine the gradation or asphalt content of the material in any load or portion of the paved roadway, samples will be taken, tested, and the results compared to the requirements of the approved job-mix formula. The results obtained in the testing will apply only to the material in question.

**TABLE II-15
PROCESS TOLERANCE**

Tolerance on Each Laboratory Sieve and Asphalt Content: Percent Plus and Minus

No. Tests	Top Size ¹	1 ½ in	1 in	¾ in	½ in	⅜ in	No. 4	No. 8	No. 30	No. 50	No. 200	A.C.
1	0.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	6.0	5.0	2.0	.60
2	0.0	5.7	5.7	5.7	5.7	5.7	5.7	5.7	4.3	3.6	1.4	0.43
3	0.0	4.4	4.4	4.4	4.4	4.4	4.4	4.4	3.3	2.8	1.1	0.33
4	0.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	2.5	1.0	0.30
5	0.0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	2.7	2.2	0.9	0.27
6	0.0	3.3	3.3	3.3	3.3	3.3	3.3	3.3	2.4	2.0	0.8	0.24
7	0.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.3	1.9	0.8	0.23
8	0.0	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.1	1.8	0.7	0.21
12	0.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	1.7	1.4	0.6	0.17

¹Defined as the sieve that has 100% passing as defined in Tabel II-13

211.09 – Adjustment system

In the event a lot of material does not conform to the acceptance requirements of Section 211.08, adjustment points will be determined as follows:

Adjustment Points for Each 1% the Gradation is Outside the Process Tolerance Permitted in Table II-15

Sieve Size	Applied in 0.1% Increments
1 1/2 in	1
1 in	1
3/4 in	1
1/2 in	1
3/8 in	1
No. 4	1
No. 8	1
No. 30	2
No. 50	2
No. 200	3

One adjustment will be applied for each 0.1 percent that the material is out of the process tolerance for asphalt content.

In the event the total adjustment for a lot is greater than 25 points, the failing material shall be removed from the road. In the event the total adjustment is 25 points or less and the Contractor does not elect to remove and replace the material, the unit price for the material will be reduced 1 percent of the unit price bid for each adjustment point.

The adjustment will be applied to the tonnage represented by the sample or samples. In the event adjustment points are applied against 2 successive lots, plant adjustment shall be made prior to continuing production.

The Contractor shall control the variability of his product in order to furnish a uniform mix. When the quantity of any one type material furnished a project exceeds 4000 tons, the variability of the total quantity furnished will be determined on the basis of the standard deviation for each sieve size and the asphalt content. In the event the standard deviation is within the ranges shown in Table II-16, the unit bid price for the material will be adjusted as indicated herein. Adjustments for standard deviation computations will not be made on more than two job mixes for the same type material.

TABLE II-16
Standard Deviation

Sieve Size & A.C.	¹ Standard Deviation Adjustment Point For Each Sieve Size & A.C.	² Adjustment Points For Each Sieve Size & A. C.	³ Adjustment Point For Each Sieve Size & A.C.
1/2 in.	3.8 - 4.7	4.8 - 5.7	5.8 - 6.7
3/8 in	3.8 - 4.7	4.8 - 5.7	5.8 - 6.7
No. 4	3.8 - 4.7	4.8 - 5.7	5.8 - 6.7
No. 8	3.0 - 3.9	4.0 - 4.9	5.0 - 5.9
No. 30	2.2 - 3.1	3.2 - 4.1	4.2 - 5.1
No. 50	1.5 - 2.4	2.5 - 3.4	3.5 - 4.4
No. 200	1.1 - 2.0	2.1 - 3.0	3.1 - 4.0
A.C.	0.27 - 0.36	0.37 - 0.46	0.47 - 0.56

A separate standard deviation will be determined by the Department for each calendar year's production of each mix type produced by a plant. The unit bid price will be reduced by 0.5 percent for each adjustment point applied for standard deviation.

The Engineer will determine the disposition of material having standard deviations larger than those shown in Table II-16.

211.10 -- Referee system -

- (a) In the event the test results obtained from one of the eight samples taken to evaluate a particular lot appear to be questionable, the Contractor may request in writing that the results of the questionable sample be disregarded; whereupon, the Contractor shall have either an AASHTO-accredited lab or Department lab perform tests on five additional samples taken from randomly selected locations in the roadway where the lot was placed. In the event the Engineer determines that one of the four tests results appears to be questionable, the Department will perform tests on five additional samples taken from randomly selected locations in the roadway where the lot was placed. The test results of the seven original, i.e. unquestioned samples will be averaged with the test results of the five road samples and the mean of the test values obtained for the twelve samples will be compared to the requirements for the mean of twelve tests as shown in Table II-15.
- (b) In the event the Contractor questions the mean of the eight original test results obtained for a particular lot, the Contractor may request in writing approval to have either an AASHTO-accredited lab or Department lab perform additional testing of that lot.

In the event the Engineer determines that the mean of the eight original test results are questionable, the Department will perform additional testing of that lot. The test results of the original eight samples will be averaged with the test results of the four additional samples taken from randomly selected locations in the roadway where the lot was placed and the mean of test values obtained for the eight samples will be compared to the requirements for the mean result of eight tests as shown in Table II-15.

If the Contractor requests additional tests, as described in (a) or (b) herein, the Contractor shall sample and have either an AASHTO-accredited lab or Department lab test the material in accordance with Department- approved procedures. The Engineer reserves the right to observe the sampling and testing.

In the event the mean of the test values obtained for the twelve samples conforms to the requirements for the mean results of twelve tests, the material will be considered acceptable. In the event the mean of the test values obtained for the twelve samples does not conform to the requirements for the mean result of eight tests, the lot will be adjusted in accordance with the adjustment rate specified in Section 211.09.

Samples of the size shown herein shall be saw cut by the Contractor for testing without the use of liquids.

Application Rate	Minimum Sample Size
125 lb/y ²	8 by 8 inches
150 lb/y ²	7 by 7 inches
200 lb/y ²	6 by 6 inches
300 lb/y ²	5 by 5 inches

211.11 --Handling and Storage of Aggregates

Aggregates shall be handled, hauled and stored in a manner which will minimize segregation and avoid contamination. Aggregates shall be stockpiled in the vicinity of the plant and on ground that is denuded of vegetation, hard, well drained or otherwise prepared to protect the aggregate from contamination. Placing aggregate directly from the crusher bins into the cold feed may be permitted, provided the material is consistent in gradation. When different size aggregates are stockpiled, the stockpiles shall be separated to prevent commingling of the aggregates.

211.12 -- Asphalt Concrete Mixing Plant

Plants used for the preparation of asphalt concrete mixtures shall conform to the following requirements:

- (a) **Certification for Plant Operation and Sampling** – There shall be a certified Asphalt Plant Technician for sampling material at the plant.
- (b) **Plant Scales:** Scales shall be approved in accordance with the requirements of Section 109.01.
- (c) **Drier:** The plant shall include a drier(s) that continuously agitates the aggregate during the heating and drying process. The aggregate shall be dried to a point at which the moisture content of the completed mixture does not exceed 1 percent as determined from samples taken at the point of discharge from the mixing operation.
- (d) **Feeder for Drier:** The plant shall be equipped with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained. Where different size aggregates are required to meet grading specifications, they must be proportioned by feeding into the cold elevator through a multiple compartment feeder bin, one bin for each size used, equipped with positive action gates that can be securely locked to maintain desired proportioning.
- (e) **Bins:** When bins are used, adequate and convenient facilities shall be provided to make possible the sampling of representative aggregate material for each bin. Each compartment shall be provided with an overflow pipe of such size and at such location to prevent contamination of the aggregate in adjacent compartments and shall be provided with individual outlet gates which, when closed, will allow no leakage.
- (f) **Thermometric Equipment:** The plant shall be equipped with an thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregate or the completed mix if the drier drum mixing plant is used.

A thermometric device shall be fixed in the asphalt feed line at a suitable location near the charging valve at the mixer unit.

Thermometric devices shall be maintained in good working condition and shall be subject to checking against the laboratory thermometer. Any instruments that do not operate or register properly shall be removed and repaired or replaced.

- (g) **Pollution Control:** Pollution control shall conform to the requirements of Section 107.14 of the Specifications.
- (h) **Equipment for Preparation of Asphalt Material:** Tanks for the storage of asphalt material shall be equipped with a heating system capable of heating and holding the material at the required temperatures. A separate storage tank or a storage tank having separate compartments shall be available for each grade of asphalt cement being used. The heating system shall be designed to heat the contents of the tank by means of steam, electricity or other approved means so that no flame is in contact with the heating surface of the tank. The circulating system for the asphalt material shall be designed to assure proper and continuous circulation during the operating period and to minimize oxidation. All pipelines shall be steam jacketed or insulated to prevent undue loss of heat. Storage facilities for asphalt material shall be sufficient for at least one day's operation or an equivalent means of supply shall be provided which will insure continuous operation.

Provisions shall be made for measuring and sampling storage tanks. When asphalt material is proportioned by volume, the temperature of the asphalt material in storage shall be uniformly maintained ($\pm 20^{\circ}$ F) during operation of the plant by means of an automatic temperature control device. A sampling valve shall be provided for sampling of each asphalt storage tank used in production of the mix.. If there are multiple storage tanks, then a dedicated valve for each tank shall be provided.

- (i) **Asphalt Control:** Asphalt material shall be accurately proportioned by volume or weight. When

volumetric methods are used, measurements shall be made by means of meters or pumps, calibrated for accuracy. The section of the asphalt line between the charging valve and the spray bar shall be provided with an outlet valve for checking the meter.

When proportioned by weight, the asphalt material shall be weighed on approved scales. Dial scales shall have a capacity of not more than 15 percent of the capacity of the mixer. The value of the minimum graduation shall not be greater than 2 pounds.

Except when drier-drum mixing plant is used, the asphalt material bucket, its valves and spray bar shall be steam jacketed or heated by other approved means. The bucket shall have a capacity of at least 115 percent of the weight of the asphalt material required in any mixture and shall be supported by fulcrums.

The asphalt shall be delivered to the mixer in multiple uniform streams for the full width of the mixer.

- (j) **Proportioning Aggregates** - Mineral filler and any bag house fines the Contractor uses shall be metered or introduced by means of an approved device for uniform proportioning by weight or by volume.

The weigh hopper shall be of sufficient size to hold the maximum required weight of aggregate for one batch without hand raking or running over. Sufficient clearance between the weigh hopper and supporting devices shall be provided to prevent accumulation of foreign materials.

The discharge gate of the weigh hopper shall be situated in such a manner that the aggregates will not segregate when dumped into the mixer. Gates on the bins and weigh hopper shall be constructed to prevent leakage when closed.

- (k) **Drum Mixer:** The aggregate shall be proportioned by a positive weight control at the cold aggregate feed by use of a belt scale, which will automatically regulate the supply of material being fed and permit instant correction of variations in load. The cold feed flow shall be automatically coupled with the asphalt flow to maintain the required proportions.

- (l) **Batch Mixer:** The batch mixer shall be of a twin pugmill or other approved type, steam jacketed or heated by other approved means and capable of producing uniform mixtures within the specified tolerances. It shall be equipped with a sufficient number of paddles or blades, operated at such speeds as to produce a properly and uniformly mixed batch. The number and arrangement of the mixer paddles shall be subject to the approval of the Engineer. Worn or defective blades shall not be used in mixing operations.

The mixer shall be provided with an approved time lock which will lock the discharge gate after the aggregates and asphalt have been placed in mixer and will not release the gate until the specified time has elapsed.

Batch type mixing plants used to produce asphalt concrete shall be equipped with approved automatic proportioning devices. Such devices shall include equipment for accurately proportioning batches of the various components of the mixture by weight or volume in the proper sequence and for controlling the sequence and timing of mixing operations. The automated system shall be designed to interrupt and stop the batching operation at any time batch quantities are not satisfied for each of the materials. A means shall be provided for observing the weight of each material during the batching operation.

The aggregate may be proportioned by cold feed controls in lieu of plant screens provided the cold aggregate feed conforms to the requirements specified in (j) herein.

Should the automatic proportioning devices become inoperative, the plant may be allowed to batch and mix asphalt materials for a period of not more than 48 hours from the time the breakdown occurs provided alternate proportioning facilities are approved by the Engineer. Written permission of the Engineer will be required for operation without automatic proportioning facilities for periods longer than 48 hours.

- (m) **Continuous Mixing Plant:** A continuous mixing plant shall include a means for accurately proportioning each size of aggregate either by weighing or volumetric measurement. When gradation control is by volume, the unit shall include a feeder mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The orifice shall be rectangular, with one dimension adjustable by positive mechanical means and shall be provided with a lock. Indicators shall be provided to show the individual gate opening in inches. The plant shall be equipped with a satisfactory revolution counter.

The plant shall include a means for calibrating gate openings by weight. The materials fed out of the bins through individual orifices shall be bypassed to a suitable test box, with each component material confined in a separate section. The plant shall be equipped to conveniently handle test samples weighing up to 200 pounds per bin and accurate platform scales shall be provided for this purpose.

Positive interlocking control shall be provided between the flow of aggregate from the bins and the flow of asphalt material from the meter or other proportioning device. This shall be accomplished by approved interlocking devices or other approved positive means.

Accurate control of the asphalt material shall be obtained by weighing, metering or volumetric measurement.

The aggregate may be proportioned by cold feed controls in lieu of plant screens provided the cold aggregate feed conforming to the requirements specified in (j) herein.

The plant shall include a continuous mixer of an approved type, which is steam jacketed or heated by other approved means. The paddles shall be of any adjustable type for angular position on the shafts and reversible to retard the flow of the mixture.

Interlock cutoff circuits shall be included to interrupt and to stop the proportioning and mixing operations when the aggregate level in the plant or the asphalt material in storage fall below that necessary to produce the specified mixture.

- (n) **Trucks, Truck Scales, and Automatic Printer System:** These shall conform to the requirements of Section 109.01.

211.13 --Preparation of Mixture

The asphalt and aggregate shall be introduced into the mixer at a temperature that will produce a mixture within the requirements of the job-mix formula.

After the required amounts of aggregate and asphalt material have been introduced into the mixer, the materials shall be mixed until a uniform coating of asphalt and a thorough distribution of the aggregate throughout the mixture is secured within the requirements of the Ross Count procedure described in AASHTO T195. Wet mixing time, based on the procedures of AASHTO T195, shall be determined by the Contractor at the beginning of production and approved by the Engineer for each individual plant or mixer and for each type of aggregate used; however, in no case shall the wet mixing time be less than 20 seconds.

The wet mixing time is the interval of time between the start of introduction of the asphalt material into the mixer and the opening of the discharge gate. A wet mixing time which will result in fully coating a minimum of 95 percent of the coarse particles, based on the average of the 3 samples and provided that none of the 3 samples result in fully coating less than 92 percent of the coarse particles, shall be the minimum wet mixing time requirement.

A dry mixing time of up to 15 seconds may be required by the Engineer to accomplish the degree of aggregate distribution necessary to obtain complete and uniform coating of the aggregate with asphalt.

211.14 --Storage System

In the event the Contractor elects to use a storage system, the system shall be capable of conveying the mix from the plant to the storage bins and storing the mix without a loss in temperature, segregation or oxidation of the mix. Storage time shall be limited by the ability of the bins to maintain the mix within the quality requirements specified herein with a maximum time limit not to exceed 10 days. Material may be stored in bins for no more than 24 hours without an approved heating system.

The conveyor system may be a continuous or skip bucket type. Continuous type conveyors shall be enclosed so that the mix temperature is maintained.

The storage bins shall be designed in a manner to prevent segregation of the mix during discharge from the conveyor into the bins and shall be equipped with discharge gates that will not cause segregation of the mix while the mix is loaded into the trucks.

Approval for the use of storage bins may be withdrawn by the Engineer in the event there is an excessive amount of heat loss, segregation or oxidation of the mix.

211.15 --Initial production

- (a) **Warm Mix Asphalt (WMA):** At the start of production, the Contractor shall place no more than 500 tons or up to one day's production as directed by the Engineer at an approved site, which may be the project site, so the Engineer can examine the process control of the mixing plant, the Contractor's placement procedures, surface appearance of the mix, compaction patterns of the Contractor's roller(s), and correlation of the nuclear density device.
- (b) **Hot Mix Asphalt (HMA):** At the start of production of a mix not previously used on a state roadway, the Contractor shall place 100 to 300 tons or up to one day's production as directed by the Engineer at an approved site, which may be the project site, so the Engineer can examine the process control of the mixing plant, the Contractor's placement procedures, surface appearance of the mix, compaction patterns of the Contractor's roller(s), and correlation of the nuclear density device.

The material shall be placed at the specified application rate and will be paid for at the contract unit price for the specified mix type. The Engineer will determine the disposition of material that was not successfully produced and/or placed due to negligence in planning, production, or placement by the Contractor.

requirements for all properties of that grade as specified in AASHTO M320 Table 1 for performance-graded asphalt binder. This certification shall be based on testing performed on samples of binder provided to the Contractor for incorporation into the mixture. Certification based on testing performed on laboratory-produced binders will not be acceptable.

The Contractor shall submit to the Engineer for Department review the source, formulation, and PG grading of the binder at least 15 days prior to the production of the SMA mixture. During mixture production, testing to determine the binder PG grade will be performed by the Department on samples taken from storage at the hot-mix asphalt plant as directed by the Engineer. The Contractor shall be responsible for obtaining the sample of binder when requested. In the event it is determined that the binder does not comply with the requirements of the specified PG grade, production shall be stopped until further testing indicates that the problem has been corrected.

- (d) Mineral Filler: Mineral filler shall consist of finely divided mineral matter such as rock or limestone dust or other suitable material. Hydrated lime and fly ash will not be allowed. Up to two mineral fillers may be blended to comply with the mineral filler requirements. Mineral filler shall conform to the requirements of Section 201 with the following modifications. The mineral filler or mineral filler blend used in surface and intermediate SMA shall have a minimum of 55 percent passing the No. 200 sieve. At the time of use, it shall be sufficiently dry to flow freely and be essentially free from agglomerations.
- (e) Fiber Additive: Cellulose fiber in either loose or pelletized form shall be used. The minimum dosage rate for cellulose is 0.3 percent by weight of the total mixture. During production, the Department may require the percentage of fiber additive to be increased if visual inspection or draindown testing on plant-produced material indicates that draindown in excess of 0.3 percent by weight of the mixture is occurring as determined in accordance with VTM-100. Allowable tolerances of fiber dosage shall be ±10 percent of the required fiber weight.

NOTE: When using pelletized fiber, the dosage rate shall be adjusted to comply with the specified minimum dosage rates for cellulose fiber. Pelletized fiber consists of cellulose fiber and a binder. The specified minimum dosage rates are based on fiber content only. Therefore, the amount of pelletized fiber added shall typically be higher than for loose fiber.

Fibers will be accepted based on the manufacturer’s certification.

TABLE II-23

Cellulose Fiber Properties

Sieve Analysis		
Method A: Alpine Sieve¹ Analysis		
Fiber Length:		0.25 inch max.
Passing	No. 100 Sieve	70% (±10%)
Method B: Mesh Screen² Analysis		
Fiber Length:		0.25 inch max.
Passing	No. 20 Sieve	85% (±10%)
	No. 40 Sieve	65% (±10%)
	No. 140 Sieve	30% (±10%)
Ash Content ³		18% (±5%) non-volatile
pH ⁴		7.5% (±1.0)
Oil Absorption ⁵		5.0% (±1.0)(times fiber weight
Moisture Content ⁶		<5%

¹ Method A: Alpine Sieve Analysis. Performed using an Alpine Air Jet Sieve (Type 200 LS). A representative 5-gram sample of fiber is sieved for 14 minutes at a controlled vacuum of 22 inches (±3 inches) of water. The portion remaining on the screen is weighed.

²Method B: Mesh Screen Analysis. This test is performed using standard Nos. 20, 40, 60, 80, 100, and 140 sieves, nylon brushes, and a shaker. A representative 10-gram sample of fiber is sieved, using a shaker and two nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated.

³Ash Content: A representative 2- to 3-gram sample of fiber is placed in a tared crucible and heated between 1100 and 1200 degrees F for not less than 2 hours. The crucible and ash are cooled in a desiccator and reweighed.

⁴pH Test: Five grams of fiber is added to 3.5 ounces of distilled water, stirred, and allowed to set for 30 minutes. The pH is determined with a probe calibrated with a pH 7.0 buffer.

⁵Oil Absorption Test: Five grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than 5 minutes to ensure total saturation. It is then placed in a screen mesh strainer (with a hole size of approximately 0.5 square millimeter), and shaken on a wrist action shaker for 10 minutes (approximately 1¼-inch motion at 20 shakes/minute). The shaken mass is then transferred without touching to a tared container and weighed. Results are reported as the amount (number or times its own weight) the fibers are able to absorb.

⁶Moisture Content: Ten grams of fiber is weighed and placed in a 250 degree F forced air oven for 2 hours. The sample is then reweighed immediately upon removal from the oven.

(f) **RAP:** Reclaimed Asphalt Pavement (RAP) material may be used as component material of SMA mixtures in conformance with the following :

1. SMA surface and intermediate mixtures containing RAP shall use the PG grade of asphalt cement designated by the mix specified on the plans or in the proposal e.g. and SMA-12.5 (76-22).
2. The final asphalt mixture shall conform to the requirements for the type specified.
3. During the production process, RAP material shall not be allowed to contact open flame.
4. RAP material shall be handled, hauled and stored in a manner that will minimize contamination. Further, the material shall be stockpiled and used in such manner that variable asphalt contents and asphalt penetration values will not adversely affect the consistency of the mixture.

248.03—Composition of SMA Mixture

The SMA mixture shall be designed and tested using a gyratory compactor and shall conform to the requirements listed in Table II-24 and Table II-25 One percent hydrated lime will be required as an antistripping additive. An alternative antistripping additive can be used only if permitted by the Engineer.

Mix Type & PG	Allowable RAP Percentage in Mix
SMA-9.5 (70-22), SMA-12-5(70-22) & SMA-19.0(70-22)	0.0 to 20.0
SMA-9.5 (76-22), SMA-12-5(76-22) & SMA-19.0(76-22)	0.0 to 15.0

**TABLE II-24
SMA Design Range**

Type No. (See Note)	Percentage by Weight Passing Square Mesh Sieves (in)							
	1	3/4	1/2	3/8	No 4	No. 8	No.30	No. 200
<i>Surface Mixes</i>								
SMA 12.5	---	100	85-95	80 max.	22-28	16-24	15-20	10-12
SMA 9.5	---	100	90-100	70-85	25-40	15-25	---	10-12
<i>Intermediate Mixes</i>								
SMA 19.0	100	85-95	50-60	30-45	---	16-24	12-16	8-10

Note: The required PG binder will be shown in parentheses as part of the mix type on the plans or proposal, e.g., SMA 12.5 (76-22).

**TABLE II-25
SMA Mixture Requirements**

Mix Type	VTM ¹ (%)	VMA Design (Min.%)	VMA Production (Min.%)	VCA Design and Production ² (%)	AC (Min.%)	Draindown (%)	Design Gyrations	Specimen Height ³
SMA 9.5	2.0-4.0	18.0	17.0	80 max.	6.3	0.3 max.	75	115
SMA 12.5	2.0-4.0	18.0	17.0	70-85	6.3	0.3 max.	75	115
SMA 19.0	2.0-4.0	17.0	16.0	30-45	5.5	0.3 max.	75	115

248.04—Acceptance

A lot will be considered acceptable for gradation and asphalt content if the mean of the test results obtained is within the tolerance allowed from the job-mix formula. The production tolerances for the control sieves and asphalt content shall be as follows:

Process Tolerance									
Tolerance on EAch Laboratory Sieve (in) and Asphalt Content (±%)									
No. Tests	Top Size	3/4	1/2	3/8	No. 4	No. 8	No. 30	No. 200	AC
1	0.0	8.0	8.0	8.0	6.0	6.0	6.0	4.0	0.60
2	0.0	5.7	5.7	5.7	4.3	4.3	4.3	2.8	0.43
3	0.0	4.4	4.4	4.4	3.3	3.3	3.3	2.2	0.33
4	0.0	4.0	4.0	4.0	3.0	3.0	3.0	2.0	0.30
5	0.0	3.6	3.6	3.6	2.7	2.7	2.7	1.8	0.27
6	0.0	3.3	3.3	3.3	2.4	2.4	2.4	1.6	0.24
7	0.0	3.0	3.0	3.0	2.3	2.3	2.3	1.5	0.23
8	0.0	2.8	2.8	2.8	2.1	2.1	2.1	1.4	0.21
12	0.0	2.3	2.3	2.3	1.7	1.7	1.7	1.2	0.17

Production tolerance for the specimen height after compaction is 4.25 to 4.75 inches.

The Contractor shall check and report the VCA of the mix during production for each gyratory sample. If the VCA of the mix exceeds the VCA of the DRC, the Contractor shall stop production and notify the Engineer. Production shall not resume until the Contractor has taken corrective action.

The Contractor shall check and report the percentage of flat and elongated particles (F&E) in the coarse aggregates of the mix design during production. When the SMA material is sampled for acceptance (gradation and AC content); two of the eight sub-lots must be selected for F&E verification in the first lot. The F&E testing will be performed on the coarse aggregate material retained on the #4 sieve in accordance with the requirements of VTM-121, after the gradation is performed. If passing results are obtained on each sample in the first lot, then F&E testing shall be performed on a frequency of every second lot of material produced (i.e. – Lots 3, 5, 7, etc.) by randomly selecting two random sub-lots. If the F&E of the mix exceeds the specified limits, the Contractor shall stop production and notify the Engineer. Production shall not resume until the Contractor has taken corrective action and the Engineer has approved the corrective action. Once production has resumed, the Contractor shall determine the F&E of the mix for two consecutive lots by randomly selecting two sub-lots per lot. If passing results are obtained for these two lots, then the F&E testing frequency shall return to every second lot of material produced.

In the event the Department determines that the mixture being produced does not conform to the approved job-mix formula and volumetric properties in Table I-B based on Department or Contractor's test results, the Contractor shall immediately make corrections to bring the mixture into conformance with the approved job-mix formula or cease paving with that mixture.

Subsequent paving operations, using either a revised or other job-mix formula which has not been verified as described herein, shall be limited to a test run of 300 tons maximum if such material is to be placed in Department project work. No further paving for the Department using that specific mixture shall occur until the acceptability of the mixture being produced has been Verified using the 300-ton constraint.

248.05—SMA Mixing Plant

Plants used for the preparation of the SMA mixture shall conform to the following:

- (a) **Handling of Mineral Filler:** Adequate dry storage shall be provided for the mineral filler that will, at a minimum, consist of a waterproof cover that shall completely cover the stockpile at all times. Provisions shall be made for metering of the filler into the mixture uniformly and in the desired quantities. In a batch plant, mineral filler shall be added directly into the weigh hopper. In a drum plant, mineral filler shall be added directly onto the cold feed belt. Equipment shall be capable of accurately and uniformly metering the large amounts of mineral filler up to 25 percent of the total mix.
- (b) **Fiber Addition:** Adequate dry storage shall be provided for the fiber additive, and provisions shall be made for accurately and uniformly metering fiber into the mixture at plus or minus 10 percent of the desired quantities.

Introduction of loose or pelletized fiber shall require a separate system that can accurately proportion, by weight, the required quantity of fiber in such a manner as to ensure consistent, uniform blending into the mixture at all rates of production and batch sizes. This supply system shall be interlocked with the other feeding devices of the plant system, and sensing devices shall provide for interruption of mixture production if the introduction of fiber fails.

Batch Plant: Loose fiber or pelletized fiber shall be added through a separate inlet directly into the weigh hopper above the pugmill. The addition of fiber shall be timed to occur during the hot aggregate charging of the hopper. Adequate dry mixing time is required to ensure proper blending of the aggregate and fiber stabilizer. Therefore, dry mixing time shall typically be increased 5 to 15 seconds. Wet mixing time shall typically be increased at least 5 seconds for cellulose fibers to ensure adequate blending with the asphalt cement.

When fiber is used, the fiber supply system shall include low level and no flow indicators and a printout of the date, time, and net batch weight of fiber.

Drum Mix Plant: When fiber is used, the fibers shall be added in such a manner as not to be entrained into the exhaust gases of the drum plant. The fiber supply system shall include low level and no flow indicators and a printout of status of feed rate in pounds per minute.

When pelletized fibers are used, they shall be added directly into the drum mixer through the RAP inlet or a specialized fiber inlet. Operation of the drum mixer shall be such as to ensure complete blending of the pelletized fiber into the mix.

- (c) **Hot Mixture Storage:** When the hot mixture is not hauled immediately to the project and placed, suitable bins for storage shall be provided. Such bins shall be either surge bins to balance production capacity with hauling and placing capacity or storage bins that are heated and insulated and that have a controlled atmosphere around the mixture. The holding times shall be within limitations imposed by the Engineer, based on laboratory tests of the stored mixture. In no case shall the SMA mixture be kept in storage more than 8 hours.
- (d) **Mixing Temperature:** The recommended plant mixing temperature for PG 70-22 should be 315 to 340 degrees F and at no time shall the temperature exceed 350 degrees F. For PG 76-22, the plant mixing temperatures shall be within the limits of the asphalt supplier's recommendations.