Pikes Peak Region
Asphalt Paving Specifications



VERSION 7
MARCH 31, 2026

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Pikes Peak Region
Asphalt Paving Specifications

1.0 General Description

These specifications cover the requirements for the construction of Superpave Asphalt Pavement Material (APM) within the Pikes Peak Region including (El Paso County, City of Colorado Springs and City of Fountain). They include the general requirements for the construction of one or more lifts of APM on a prepared surface. The work shall consist of the preparation of the APM meeting the requirements herein, and the placement of the APM to the lines, grades, thickness, and typical cross sections shown on the plans or established by the Owning Agency Engineer. When more than one lift is required, each lift shall be compacted to the required density prior to the placement of the next lift.

In these specifications, the following terminology listed in Table 1.01 defines the traffic and volume levels for the different designations.

Table 1.01
Traffic and Volume Designation

Designation	Volume and Loading Level	Colorado Springs	El Paso County (ADT)
Low	≤ 300,000 ESALs *	Major/Minor Collector/Local	Local and Rural Collectors
Moderate	> 300,000 to ≤ 2,500,000 ESALs*	Minor Arterial, Industrial Collector	Rural Minor Arterials, Urban Collectors, and Urban Minor Arterials
High	> 2,500,000 ESALs*	Minor Arterial, Major Arterial, Freeway/Expressway	Principal Arterials and Expressways
Trails and Pathways	< 100,000 ESALs*- able to accommodate a 4,000 lb vehicle for safety and maintenance purposes		
Parking Lots	25% of volume used for entrance roadways		

*ESAL (Equivalent Single-Axle Loads)

2.0 Materials

The APM shall be a mixture of aggregate, approved filler or additives, and asphalt binder, and may include reclaimed asphalt pavement (RAP). The materials used in the manufacture of APM shall meet the following requirements:

Aggregates

Aggregates shall be of uniform quality, clean, hard, durable particles of crushed stone, crushed gravel, natural gravel, or crushed slag free from clay balls, vegetable matter, or other deleterious materials meeting the requirements in Table 2.01.

The coarse and fine aggregates for the APM shall be graded and combined in such proportions that the resulting composite blend meets the grading requirements of the job mix formula (JMF).

Aggregates meeting the requirements in Table 2.01 shall be used to develop the JMF for the APM. The aggregate shall be composed of clean, angular, coarse textured, and comprised of two or more fractured faces. Natural sand may be used to obtain gradation of the blended aggregate mixture but should not exceed 25 percent of the aggregate. If the percent of aggregate passing the #4 sieve is greater than 10 percent by weight of the individual aggregate sample, plasticity will be determined in accordance with American Association of State Highway and Transportation Officials Testing procedures (AASHTO) T 90. The gradation of the aggregates used in the mixture shall meet the criteria shown in the Aggregate Master Range, Table 2.02, and shall not vary from the lower limit on one sieve to the higher limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine. The nominal size aggregate used in the APM shall not be more than one-third the thickness of the compacted APM lift being constructed.

TABLE 2.01
AGGREGATE PROPERTIES

Property	**Test Procedure**	**Coarse Retained on #4 Sieve**	**Fine Passing the #4 Sieve**
Fine Aggregate Angularity[2] Traffic Level Low to Moderate; Trails and Pathways Traffic Level High and Parking Lots	AASHTO T304 Method A		 40% Minimum 45% Minimum
Fractured Faces (minimum of 2)	CP-45[1]	70% Minimum	
LA Abrasion Micro- Deval	AASHTO T 96 CP-L 4211	45% Maximum 18% Maximum	
Flat and Elongated Pieces 5:1	ASTM D4791	10% Maximum	
Sodium Sulfate Soundness	AASHTO T 104	12% Maximum Combined Coarse and Fine	
Sand Equivalent [2]	AASHTO T 176		45% Minimum

[1]CP designates the most recent Colorado Department of Transportation material Testing Procedures.
[2]Tests are for the combined or blended samples.

TABLE 2.02
AGGREGATE MASTER RANGE FOR ASPHALT PAVEMENT MATERIAL MIXTURES

Sieve Size	Percent by Weight Passing Square Mesh Sieves		
	Grading S	**Grading SX**	**Grading ST**
1"	100		
¾"	90 - 100	100	*
½"	*	90 – 100	100
⅜"	*	*	90 – 100
#4	*	*	*
#8	23 - 49	28 – 58	28 – 58
#30	*	*	*
#200[1]	2-8	2 – 10	2 – 10

*These additional screens will be established for the Contractor's Process Control Testing using values from the Mix Design gradation.
*Production samples should adhere to the individual limits established from the approved design and Table 4.07

Mineral Filler

If mineral filler is required to meet the JMF, it shall conform to the requirements of AASHTO M 17. It shall consist of rock dust, slag dust, hydrated lime, hydraulic cement, fly ash, or other suitable mineral matter. Mineral filler shall have a plasticity index not greater than four (4), excluding hydrated lime and hydraulic cement. Mineral filler shall meet the grading limits shown in Table 2.03 The maximum amount of allowable hydrated lime or hydraulic cement shall not exceed three (3) percent by weight of mix.

TABLE 2.03
MINERAL FILLER GRADING LIMITS

Sieve Size	Mass Percent Passing
#30 (600 µm)	100
#50 (300 µm)	95 – 100
#200 (75 µm)	70 – 100

Additives

Anti-Strip shall be added into the APM. Anti-Strip agents may be liquids (added to the binder), lime (added to the aggregates), or other products, and shall be submitted for approval by the Owner/**AGENCY**.

The minimum value for Tensile Strength Ratio (TSR) shall be 80% for the mix design and 70% during production.

Hydrated Lime

When hydrated lime is used it shall be added to the aggregate. Hydrated lime shall conform to ASTM C 207, Type N (AASHTO M 303, Type I). The residue retained on a #200 (75µm) sieve shall not exceed 30 percent when determined in accordance with ASTM C 110.

Liquid Anti-Strip

There are various types of liquid Anti-Strips. Amine and Organo-silane type liquid Anti-Strip additives are physically mixed with the asphalt binder.

Liquid Anti-Strip agents shall be added per the manufacture's recommendations. Typical product dosages are provided in Table 2.04.

The use of liquid anti-strip will require verification testing (e.g. Lottman's) approved by the agency.

TABLE 2.04
LIQUID ANTI-STRIP DOSAGE RATES

Type	Typical Dosage Rate
Amine	0.4% to 0.8%
Organo-silane	0.05% to 0.15%

Fiber Reinforcement

Fiber reinforcement shall conform to ASTM 8395. When fiber reinforcement is used the contractor shall be experienced in incorporating reinforcing fibers and the paving contractor shall be experienced in placing fiber reinforcement into the APM. Method statements and example projects may be requested prior to approval.

Acceptable products are ACE FIBER™, FORTA-FI®, or an approved equivalent.

Any changes to the asphalt mix or fiber material beyond the allowed tolerances during production shall be disclosed by the representative and submitted in writing to the Engineer by the Contractor as a change in mix design.

The Contractor shall introduce reinforcement fiber strands through the Recycled Asphalt Pavement collar, or prior to the addition of liquid asphalt cement, with a metered blower system. The Contractor shall ensure that reinforcement fiber strands are added at the specified rate per manufactures recommendations.

If there is evidence of fiber balls at the discharge chute, the Contractor shall immediately adjust operations according to the manufacturer's recommendation to correct the problem. The Contractor shall also remove all observed fiber balls during placement. The Engineer may require the Contractor to cease operations if fiber balls are present, until a correction plan has been submitted and approved. Any delays due to shutting down due to the presence of fiber balls shall be considered non-excusable and non-compensable.

The Contractor shall provide the Engineer with documentation detailing total reinforcement fiber strands added to the APM at the end of each day's production. The documentation shall include total reinforcement fiber strands added and the percentage of total reinforcing fibers that are virgin aramid fibers.

Warm Mix Asphalt (WMA) and Compaction Aids

WMA and compaction aids chemical products which display Anti-Stripping characteristics will be classified as a liquid Anti-Strip additive.

Warm Mix Asphalt and compactions aids shall meet the requirements of Colorado Department of Transportation CDOT CP-59.

Reclaimed Asphalt Pavement (RAP)

RAP is allowed in the APM. RAP shall be of uniform quality and gradation with a maximum size particle no greater than the nominal maximum aggregate size in the APM. APM mix designs containing RAP shall meet the same gradation requirements as a virgin APM mix. APM mix designs containing up to 20 percent RAP can be submitted for approval for the calendar year. APM mix designs containing more than 20 percent RAP (up to a maximum of 25 percent) shall require a binder grade adjustment by reducing the high and the low temperature PG grades by one grade (6 degrees C) and shall be approved by the owner agency on a project specific basis. The APM mix with RAP shall meet all the requirements for virgin APM mix, as contained herein.

The Engineer may require the contractor to maintain separate stockpiles for each type of RAP material. All processed material shall be free of deleterious materials and segregation shall be minimized. Any RAP material that cannot be readily broken down in the mixing process, and/or affects the paving operation, shall be processed prior to mixing with the virgin material.

Asphalt Binder

Recommended Performance Graded asphalt binders are listed in Table 2.05, Binder Grades for APM, and shall meet the requirements listed in Table 2.06: Properties for Performance Graded (PG) Binders. Any asphalt binder supplied must be from an approved source and shall be certified by CDOT.

TABLE 2.05
BINDER GRADES FOR APM

Traffic Levels [1]	Binder Grades
Low	PG 58-28
Medium	PG 58-28 or PG 64-22 [2]
High	PG 64-28 [3] PG76-28, PG[3] 64-22 (bottom and intermediate mats only)
Trails and Pathways	PG 58-28
Parking Lots	PG 58-28

[1] For 20-Year Designs.
[2] Alternate binder to be approved by the Agency Engineer.
[3] Shall be used for a minimum of the top mat when roadways are designated collector or higher (e.g. major collector or arterial); as specified by the Engineer.

The Contractor shall provide to the owner/agency acceptable "Certification of Compliance" of each applicable asphalt binder grade that will be used on the project. Binder grades other than those shown above shall not be used unless the proposed binder and the mix design are approved by the owner/agency.

Mixture Binder Selection

The binders in the APM will depend on the local traffic level, traffic conditions, pavement lift, elevations, and agency requirements. Binder grade selection for the APM mixture for different traffic levels are shown in Table 2.05.

Tack Coat Material Requirements

Tack coat material shall be an Emulsified Asphalt conforming to AASHTO M 140 or M 208 for the designated grades.

Material Acceptance

Prior to the delivery of materials to the job site, the Contractor shall submit certification tests to the Engineer for approval, showing all materials to be used on the project meet the appropriate specifications. The certification shall show the appropriate test(s) for each material, the test results, and a statement that the materials meet the appropriate specification. Materials certification tests shall occur within the previous 12 months. If the Engineer requests samples of the materials for verification testing prior to and/or during the production of the APM, the Contractor shall deliver the requested materials to the owner's designated representative.

TABLE 2.06
PROPERTIES OF PERFORMANCE GRADED BINDERS

Property	PG Graded Binder Requirements				AASHTO Test No.
	58-28	**64-22**	**64-28**	**76-28[1]**	
Original Binder Properties					
Flash Point Temperature, °C, minimum	230	230	230	230	T 48
Viscosity at 135 °C, Pa·s, maximum	3	3	3	3	T 316
Dynamic Shear, Temperature °C, where G*/Sin @ 10 rad/sec ≥ 1.00 kPa	58	64	64	76	T315
Ductility, 4°C (5cm/min) cm, minimum			50		T 51
Toughness, joules, minimum			12.4		CP L-2210[2]
Tenacity, joules, minimum			8.5		CP L-2210[2]
RTFO Residue Properties AASHTO T 240					
Mass Loss, percent maximum	1	1	1	1	T 240 CPL 2215
Dynamic Shear, Temperature °C where G*/Sin @ 10 rads ≥ 2.20 kPa	58	64	64	76	T315
Elastic Recovery, 25 °C, percent minimum				50	T-301
Ductility, 4 °C (5 cm/min) cm, minimum			20		T 51
Pressure Aging Vessel Residue Properties, Aging Temperature 100 °C AASHTO R28					
Dynamic Shear, Temperature °C where G*/Sin @ 10 rads ≤ 5000 kPa	19	25	22	28	T315
Creep Stiffness, @ 60 s, test Temp. in °C	-18	-12	-18	-18	T-313
S, maximum, MPa	300	300	300	300	T313
m-value, minimum	0.3	0.3	0.3	0.3	T313

[1] Special grades used for unique loading or climate conditions.

[2] CDOT Test Method.

3.0 Asphalt Pavement Material Mixture Composition

The APM shall be composed of well-graded aggregate, mineral filler, and/or asphalt binder, and if needed, additives as described above.

Mix Design

The Contractor shall submit the mix design to the owner/agency for approval seven (7) days prior to the beginning of paving operations. The mix design for all mixtures used on the project shall be approved by the owner/agency prior to the start of any paving operation. The mix design of all mixtures used shall be developed using the CDOT Superpave mix design procedures and shall be stamped (sealed) by an engineer licensed in the State of Colorado practicing in this field. If any component of the mix design is changed, a resubmittal of the mix design will be required and approval obtained by the owner/agency prior to use.

The Contractor shall submit as part of the mixture design the following items:

- Source(s) of materials.
- Aggregate gradation, specific gravity, source and description of individual aggregates and the final mixture blend.
- Aggregate physical properties.
- Source and grade of PG binder along with binder certification.
- Proposed JMF: aggregate and additive blending, final gradation shown on a 0.45 power graph, optimum binder content.
- Mixing and compaction temperatures.
- N_{des} (N = number of gyrations).
- Mixture properties determined at the minimum of four binder contents and interpolated at optimum and graphs showing mixture properties versus binder content.
- Additives - product name and manufacturer.
- When a liquid Anti-Strip additive is used, the submittal shall include the following information with the mix design submission:
  - Information on the type of liquid Anti-Strip additive to be supplied, including product name, product manufacturer/supplier - Additive rate
  - TSR values for the treated mixes
  - The proposed method for incorporating the additive into the plant produced mix.
  - Liquid Anti-strip Agent shall be added to the specified PG grade binder, manufactures recommendation.
- Percent of RAP, if used in the mixture.

The mix design(s) shall meet the requirements of Table 2.02 - Aggregate Master Range for Asphalt Pavement Material Mixtures, Table 2.05 - Binder Grades for APM, Table 3.01 - Superpave Mixture Properties, and Table 3.02 - Voids in Mineral Aggregate. Mixes shall be designed for air voids of 3-4 percent with a target of 3.5 percent, unless approved by the Agency Engineer. The APM will be designed for the traffic level, nominal aggregate size and binder grade designated or as specified in the Project Special Provisions.

TABLE 3.01
SUPERPAVE MIXTURE PROPERTIES

Test Property	Trails Parking Lots	All Traffic Levels
Design Gyrations, N_{des}	50	75[1]
Hveem Stability (CP-L 5106)	28 min.	28 min.
Voids Filled w/Asphalt, (VFA), % (AI-MS-2)*	70 - 80	65 - 80
Lottman, Tensile Strength Ratio, % Retained (CP-L 5109) (Optimum AC)	80 min. [2]	80 min. [2]
Dry Split Tensile Strength, PSI, (CP-L 5109)	30 min.	30 min.
Dust to Asphalt Ratio (CP-50)	0.6-1.2	0.6-1.2

*AI MS-2 = Asphalt Institute Manual Series 2
[1] Unless otherwise specified by the Engineer.
[2] Lottman requirement is 80 min. for mix design and 70 min. for field acceptance.

TABLE 3.02
VOIDS IN MINERAL AGGREGATE

Nominal Maximum Aggregate Size * (NMAS)	Minimum VMA - %		
	Design Air Voids - %		
	3	3.5	4.0
3/8”	15.5	15.6	15.7
1/2"	14.5	14.6	14.7
3/4"	13.5	13.6	13.7

The nominal maximum aggregate size is one sieve size larger than the first sieve to retain more than 10%.

If the Contractor proposes to use RAP in the APM, all resulting mixtures must meet the same requirements as mixtures that do not contain RAP. The maximum aggregate size contained in the combination of RAP and new aggregate shall not exceed the maximum specified in Table 2.02.

Plant Mix Production Verification

Mixture(s) being produced by the plant shall be verified during initial production or prior to the start of the placement of the mixture(s). Verification shall be performed by a **LabCAT Level C** certified technician(s) to verify the volumetric properties of the mixture(s). Verification shall consist of three (3) consecutive tests, each test representing a separate production run, that have met all the requirements of Table 3.03. If the mixture(s) were produced for another project within the last 90 days, verification results from that project can be submitted for this verification. Superpave mix design volumetric tolerances for the approved APM(s) shall be within the limits shown in Table 3.03.

TABLE 3.03
APM DESIGN VERIFICATION TOLERANCES

Property	Tolerance
Air Voids	± 1.2%
VMA	± 1.2%
Asphalt Binder Content	± 0.4%
Stability	Applicable minimum

4.0 Asphalt Pavement Material Construction

Pre-paving Meeting

Prior to the start of the paving season, project, or operation, all key parties involved in the supply, haul, placement, compaction, inspection and process control, and owner acceptance (PC/OA) of the APM shall attend a pre-paving meeting to go over procedures and acceptance of the APM. The layout and PC for joints shall also be discussed. The meeting may be scheduled by the Engineer. Areas of responsibility and contact names and phone numbers will be shared. Refer to the Guideline for Pre-Paving Meetings, Appendix A.

Paving Schedule

The Contractor shall arrange the work in such a manner as to cause minimum inconvenience to the traveling public and the abutting property owners. The Contractor shall submit to the Engineer a plan of this operation. In general, the Contractor shall be allowed to proceed as he proposes. However, the Engineer retains the authority to order the Contractor to schedule the proposed operation in another manner if such a change in schedule is to the benefit of the owner and beneficial to the interests of a good project. The Contractor shall arrange to have the haul vehicles operate over roads that will not be damaged by such vehicles. The Contractor shall provide all necessary Traffic Control in conformity with the current MUTCD requirements.

Weather Restrictions

The APM shall be placed on properly constructed, tested, and approved surfaces free of standing water, frozen subgrade, and snow and/or ice. During light rain events or other less than ideal conditions, the contractor shall perform extra Process Control density testing, in accordance with Industry Best Practices, to assure that the pavement meets project specifications. The APM shall be placed in accordance with the temperature limits shown in Table 4.01 and only when weather conditions permit the pavement to be properly placed and compacted, as determined by the Engineer.

Placement and compaction of the APM may be accomplished at temperatures less than shown in Table 4.01 when meeting the compaction requirements stated herein and obtaining approval from the controlling governmental agency. Approval for placement at temperatures less than shown in Table 4.01 is based on a Process Control Plan (PCP) specific to cold weather paving, submitted by the contractor and approved by the owner agency prior to authorizing asphalt placement in temperatures below those recommended in Table 4.01. The PC will outline how the contractor plans to modify their regular operations when it comes to mixing, hauling, laydown, compaction, and PC testing to provide asphalt pavement that meets the construction requirements.

TABLE 4.01
APM PLACEMENT TEMPERATURE RECOMMENDATIONS:

Paving Course	Thickness	Unmodified Asphalt Binder Minimum Surface and Air Temperature °F	Modified Asphalt Binder Minimum Surface and Air Temperature °F
Surface	1 ½ - < 3"	50	60
Surface	≥ 3"	45	50
Subsurface	1 ½ - < 3"	40	40
Subsurface	≥ 3"	35	35

Air temperature is to be taken in the shade. Surface is defined as the existing base on which the new pavement is to be placed.
CDOT Table 401-3 for Placement Temperature Limitations in ºF shall be observed for thicknesses < 1 ½".
Paving outside the recommended temperatures requires adherence to warm mix asphalt process control plan approved by the owner/agency.

APM Production Facilities

The APM plant used to produce the asphalt aggregate mixture shall meet the requirements of AASHTO M 156 and shall have adequate capacity and be maintained in good mechanical condition. The plant shall control dust, smoke, or other contaminants such that it meets the Colorado Air Quality Control Act, Title 25, Article 7, Colorado Revised Statutes (CRS) and all regulations promulgated there under.

Scales

The APM shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy.

Inspection of Plant

The Engineer or authorized representative shall have access, at all times, to all areas of the plant to check the adequacy of the equipment, inspect the operation of the plant, verify weights, proportions, and material properties, and to check the temperatures maintained in the preparation of the mixtures.

Storage Bins and Surge Bins
APM may be stored provided the characteristics of the mixture are not altered by such storage.

If the Engineer determines there is an excessive amount of heat loss, segregation, or oxidation of the mixture or other adverse effects on the quality of the finished product due to the temporary storage, corrective action shall be taken. Unsuitable mixture shall be disposed of at the Contractor's expense. In no case shall APM be stored more than 60 hours from time of production.

Hauling Equipment

Trucks used for hauling APM shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent material. Petroleum distillates such as kerosene or fuel oil will not be permitted. Each truck shall have a cover of canvas or suitable cover to protect the mixture from adverse

weather and to maintain temperature of the mixture. When necessary, to ensure the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers securely fastened.

Placement Equipment

Pavers shall be self-propelled, with activated screed assemblies, and heated as necessary, to spread and finish the APM to the specified width, thickness, smoothness, and grade shown on the plans. The pavers shall have sufficient power to propel themselves and the hauling equipment without adversely affecting the finished pavement surface.

The receiving hopper of the paver shall have sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at consistent speeds to apply the mixture in an even, continuous layer, avoiding stop and go operations. If an automatic grade and slope control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from a reference line or through a system of mechanical sensors or sensor-directed mechanisms, which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within ± 0.1 percent.

If the Contractor fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

Compaction Equipment

All compaction equipment used on the project for obtaining the required density of the APM pavement shall be self-propelled vibratory, steel wheel, or pneumatic tire type capable of obtaining 94% (± 2%) of the maximum theoretical density without crushing the aggregate. They shall be in good condition and capable of operating at slow speeds to avoid displacement and tearing of the APM mixture. Vibratory rollers shall be equipped with separate energy and propulsion controls. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment, which causes excessive crushing of the aggregate, will not be permitted.

Asphalt Pavement Material Mixture Production

The APM mixture shall be produced in a plant meeting the requirements of Section 4. D. The dried aggregates and asphalt binder shall be combined in the plant in the quantities required to meet the JMF.

Preparation of the Asphalt Binder

The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the binder material to the plant at a uniform temperature. The temperature of the asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles but shall not exceed the maximum temperature prescribed by the asphalt binder refiner.

Preparation of the Aggregate

The aggregate for the mixture shall be dried, and the temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F when the asphalt is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain

complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability. When hydrated lime is required to achieve complete and uniform coating of the aggregate by the asphalt binder, it shall be added to the aggregate in either slurry or a dry form and then thoroughly mixed in an approved pug mill. The slurry shall contain a minimum of 70 percent water by weight. If dry hydrated lime is used, it shall be added to the wet aggregate at a minimum of two (2) percent above saturated surface dry and then mixed thoroughly in an approved pug mill. Care should be taken to not add more moisture to the aggregate than required to insure proper coating.

Preparation of the Asphalt Pavement Material Mixture

The heated and dried aggregates and the asphalt binder shall be combined by weight in the mixer in the amount specified by the JMF. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt cement is uniformly distributed throughout the aggregate. Baghouse fines shall be fed back to the mixing plant in a uniform and continuous manner to maintain uniformity in the mixture. The baghouse, fines feeder, auger, and related equipment shall be in good working condition and operated in accordance with manufacturer's recommendation. If the Engineer determines that non-uniform operation of the equipment is detrimental to the mixture, paving operations may be suspended until the Contractor takes appropriate action.

The temperature of the APM, for different asphalt binder grades, when discharged from the plant, shall be within the maximum and minimum limits shown in Table 4.02. The APM shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95% minimum in accordance with AASHTO T 195) and allows the required compaction to be achieved.

Warm Mix Asphalt Production

The use of warm mix asphalt (WMA) is allowed, provided all material requirements and specification standards are met and as approved by the owner/agency. Use of WMA must also comply with the CDOT-approved list of Warm Mix Asphalt Technologies and Warm Mix Asphalt Contractors (CP-59).

The contractor shall provide a process control plan for the production and placement of WMA to be approved by the owner/agency.

TABLE 4.02
APM TEMPERATURE LIMITS[3, 4]

Asphalt Grade	Minimum Mix Discharge Temperature, °F[1]	Minimum Delivered Mix Temperature, °F[2]
PG 58 - 28	275	235
PG 64 - 22	290	235
PG 64-28	320	280
PG 76-28	320	280
All temperatures shall be determined using a calibrated thermometer.		

[1]The maximum mix discharge temperature shall not exceed the minimum discharge temperature by more than 30 °F.
[2] Delivered mix temperature shall be measured from the paver hopper.
[3] These temperature limits shall apply to warm mix asphalt (WMA). WMA shall be produced at temperatures in accordance with the APM technology and to meet production and compaction specifications as accepted by the Agency. Deviation from this Temperature Limit table shall require an approved process control plan (PCP) by the owner agency.
[4] Reference the supplier's recommendation for temperatures; this varies from producer to producer and asphalt supplier; producers shall follow the viscosity charts provided by the asphalt supplier.

Preparation of the Underlying Surface.

Preparation of the underlying surface includes subgrade, milled, full-depth reclamation, etc. The APM shall be placed on a prepared surface as outlined by the owner/agency. Prior to the placing of the mixture, irregularities in the underlying surface shall be brought to uniform grade and cross section. The surface shall be cleaned of all dust and debris. A tack coat shall be applied as required by the owner/agency.

Tack Coat

This work consists of preparing and treating the surface receiving the APM in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer. Existing asphalt surfaces receiving an asphalt overlay, existing vertical concrete surfaces such as curb, gutter, cross pan(s), and manholes, or the underlying courses of multi-course asphaltic pavement structure, shall receive a tack coat to ensure bonding of the new mat, or as directed by the engineer.

The asphaltic material for tack coat shall meet the requirements of Section 2.E.2. The emulsified asphalt- shall be diluted to not more than 1:1 with water and applied at a rate of 0.08-0.2 gallons per square yard of diluted material. The Engineer may direct other application rates to match the age and/or condition of the surface.

Before applying the tack coat, surfaces shall be cleaned of all dirt and other debris to ensure adequate bond between tack surface and asphaltic mat. Tack coats shall not be applied when the surface to receive the tack coat is wet or when weather conditions would prevent the proper construction of the tack coat. The surface shall be allowed to cure to permit drying and setting of the tack coat prior to the paving operation.

The Contractor shall provide equipment for heating and uniformly applying the tack coat material. The distributor or equipment for applying the tack coat shall be capable of uniformly spraying the material at an even temperature and uniform pressure on variable widths of surface up to 15 feet in width at readily determined and controlled rates as required.

The tack coat shall be applied in a uniform and continuous spread. When traffic is maintained, sufficient

width shall be left to adequately handle traffic. Care shall be taken so the application of the tack coat materials at the junctions of spreads does not exceed the specified quantity. Excess material shall be removed or distributed as directed. Tack coat shall not be placed on any surface where traffic will travel on the freshly applied material.

Patching

Remove the backfill material to the depth and extent required by the owner/agency engineer. Prepare the subsurface with the required base course and/or Portland Cement concrete subsurface as specified by the owner/agency engineer. Depths and/or thickness of base course, Portland Cement concrete, and/or asphalt pavement shall be as indicated on the drawings. The asphalt pavement shall be a minimum of four (4) inches or equal to the existing pavement thickness, whichever is greater or as specified in the plans or specifications. The backfill and base course material shall be thoroughly compacted to the densities as specified by the owner with a roller for large areas and smaller hand operated compactor for small patches. Thoroughly compacted, where found in these specifications, is intended to mean compaction by the contractor using their best effort or until further consolidation is unlikely using mechanical or hand tampers where a roller cannot be used.

Existing pavement may be rough cut initially in conjunction with trenching; however, a square, even vertical cut shall be made in the existing APM pavement after placement of backfill and prior to pavement replacement. The square vertical cut shall be made at a minimum of 12 inches back from the limits of excavation line as designated by the agency inspector. Before placement of the new pavement, the cut edges shall be thoroughly cleaned, and a tack coat shall be uniformly and evenly applied to vertical faces. The patch shall be made with placement of an approved APM.

In large patches where a self-propelled paving machine is used to place the APM. The material shall be placed to the grade and thickness required to allow for compaction by rolling. The APM shall be compacted using the number, weight, and type of rollers required to provide 94% (+/- 2%) of the maximum density of the approved JMF. Rolling shall continue until roller marks are eliminated. These areas are subject to testing if required by the owner if it meets Table 4.06 footnote 2.

In small patches, where the use of rollers is not practical, the material shall be hand placed or placed with a spreader box without segregation of the material and thoroughly compacted by best effort and no further consolidation is possible in the pavement.

Inspection for large and small patches shall be performed and the mix placement temperatures shall be monitored to ensure specified placement temperature following Tables 4.01 and 4.02 and best compaction effort is achieved following the compaction temperature ranges.

Hauling of APM

Transporting the APM from the plant to the job site shall be done in vehicles meeting the requirements of Section 4.E. The Contractor shall have an adequate number of vehicles so delivery of the APM can be continuous with a minimum of interruptions of material to the paving equipment for a continued non-stop paving operation and before the temperature of the APM material falls below 235 °F for non-modified material or not less than 280 °F for polymerized modified material. WMA shall be delivered at temperatures to meet production and compaction specifications. Deliveries shall be planned so the placing and compaction of all the mixture prepared for one day's operation can be completed during daylight unless adequate artificial lighting is provided by the Contractor and approved by the Engineer. When the atmospheric temperature is less than 50° Fahrenheit, all loads shall be delivered continuously in covered vehicles meeting the requirements in Section 4.E. Hauling over newly placed mixture shall not be permitted until the mixture has been compacted as specified and allowed to cool sufficiently so vehicular traffic does

not damage or deform the final lift.

Placing of APM

The APM shall be placed using equipment meeting the requirements in Section 4.F to the established grade and required thickness over the entire width or partial width as practicable.

The mixture shall be laid upon an approved surface, spread, and struck off to obtain the required grade and elevation after compaction. The thickness of the mixture being placed should be such that after compaction is achieved, the finished mat will be even with the existing adjacent mat. Raking is discouraged and should not be allowed if it is causing segregation in the mat. Casting or raking that causes any segregation will not be permitted.

On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness plus the amount necessary to achieve the required compacted thickness. Carefully move or minimally work the APM mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt cement require more rapid completion of handwork areas than for normal mixtures. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Excessive starting and stopping should be avoided. If stopping and starting of the paving operation cannot be avoided, it should be done as rapidly as possible within reason. A construction joint shall be placed any time the paver stops, and the screed drops enough to cause a surface dip in violation of Table 4.08 for smoothness, or the mat temperature falls enough that the compaction cannot be obtained as specified.

When echelon paving is permitted and approved by the Engineer, production of the mixture shall be maintained so pavers can be used in echelon to place the wearing course in adjacent lanes.

When material is shoveled, it shall be deposited by turning the shovel over above the desired area. No "slinging" of the shovel will be permitted. The hand placed material shall be smoothed and left higher than the machine laid material by about 1/4 inch per inch of depth prior to rolling. If the machine laid mixture has been rolled, then the hand laid mixture shall be smoothed and left higher than the rolled pavement by about 1/4 inch per inch depth. The majority of the raker's work shall be done with a lute rather than a tined rake.

Segregation

The APM shall be transported and placed on the roadway without segregation. If at any time the Engineer observes segregated areas of pavement, s/he will notify the Contractor immediately. Further laydown operations will then be at the Contractor’s risk. Any segregated areas behind the paver shall be removed upon verification. The segregated material shall be replaced with specification material.

After rolling, segregated areas will be delineated by the Engineer and evaluated as follows:

The Engineer will delineate the segregated areas to be evaluated and inform the Contractor of the location and extent of these areas within two calendar days, excluding weekends and holidays, of placement.

In each segregated area or group of areas to be evaluated, the Contractor shall take five 10-inch cores at random locations designated by the Engineer. In accordance with CP 75, the Contractor shall also take five 10-inch cores at random locations designated by the Engineer in non-segregated pavement adjacent to the segregated area. These cores shall be within 30 feet of the boundary of the segregated area and in the newly placed pavement. The coring shall be in the presence of the Engineer and the Engineer will take immediate possession of the cores. The Contractor may take additional cores at the Contractor’s expense.

Gradation of the aggregate of the cores will be determined in accordance with CP 46.

The core aggregate gradations from the segregated area will be compared to the core aggregate gradations of the corresponding non-segregated area.

Two key sieves of the core gradations from the segregated area will be compared to the core gradations from the corresponding non-segregated area to determine the difference. If differences for both key sieves exceed the allowable difference specified in Table 4.03, the area is segregated.

TABLE 4.03
SEGREGATION DETERMINATION

Mix Grading	Key Sieves	Allowable Difference, %
ST,SX, S	2.36 mm (#8)	9
	4.75 mm (#4)	

Segregated areas in the top lift shall be removed and replaced, full lane width, at the Contractor's expense. The Engineer may approve a method equivalent to remove and replace if the results in a non-segregated top lift. Segregated areas in lifts below the top lift, smaller than 50 square feet per 100 linear feet of lane width, will be corrected by the Contractor at the Contractor's expense in a manner acceptable to the Engineer. Segregated areas larger than 50 square feet per 100 linear feet of lane width in any lift shall be removed and replaced, full lane width, by the Contractor at the Contractor's expense.

If the area is determined to be segregated, the coring(s) will be at the expense of the Contractor. If the area is determined to be non-segregated, the Engineer shall reimburse the Contractor the actual cost for obtaining the 10 cores.

Lift Thickness

Each lift of compacted asphalt pavement shall be of uniform thickness. The minimum compacted lift thickness shall be three (3) times the nominal aggregate size of the mixture. The maximum compacted lift thickness shall not exceed six (6) times the nominal maximum aggregate size unless the Contractor can demonstrate the ability to achieve required compaction of thicker lifts without damaging the surface or fracturing the aggregate. Placement of lifts thicker than four (4) inches compacted asphalt shall be approved by the Owning Agency Engineer prior to placement. These thicknesses are summarized in Table 4.04.

The final lift, when placed adjacent to guttering, shall extend ¼ to inch above the lip of the gutter when compacted for a catch curb and gutter and shall be even with the street face for a spill curb and gutter at the time of construction. The asphalt mat shall be flush with the lip of gutter and/or concrete edge at all pedestrian crossings and/or curb ramps.

The average compacted total pavement thickness shall be determined as specified in Table 4.08.

TABLE 4.04
HMA GRADING SIZE AND LAYER THICKNESS

HMA Grade	Nominal Maximum Aggregate Size (NMAS)	Overlay Layer Thickness (Compacted Thickness)	
		Minimum (inches)	Maximum (inches)
SF	No. 4 Sieve	0.75	1.5[1]
ST	3/8 Inch	1.125	2.5
SX	½ inch	1.5	3
S	¾ Inch	2.25	3.5 (4-in with approval)

[1] Layers of SF mixes may be placed thinner as needed to taper thin lift to site conditions (e.g. rut filling)

Joint Construction

The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and to obtain the required density. All joints shall have the same texture and smoothness as other sections of the mat and shall meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course.

The free edge of the paved pass shall be laid as straight as possible and to the satisfaction of the Engineer. This joint shall be spray tack coated prior to placement of adjacent paving.

The new compacted mat shall overlap the adjacent previous placed mat no more than 1.5 inches. Excess overlap or thickness shall not be raked or cast onto the new mat but shall be wasted by pulling back and removing. The hot edge shall be blocked or bumped in a smooth line consistent with the previous longitudinal edge. Minor raking will only be allowed to correct major grade problems or provide mix around manholes and meter covers.

Longitudinal Joints

The longitudinal joint in both a new pavement and an overlay pavement layer shall offset the joint in the layer immediately below by a minimum of 6 (six) inches. In multiple lift (three lifts or more) construction, the joint in any succeeding lift shall not be placed in line of any of the previous lifts. The joints in any pavement layer shall not fall in a wheel path. The Contractor shall submit a longitudinal joint and pavement marking plan three (3) days prior to the Pre-Paving Conference. The plan shall show the location and configuration of the proposed longitudinal joints and pavement markings and shall detail the methods to be used in the field to establish a control line. The Contractor shall use a continuous string line to delineate every longitudinal joint during paving operations. All exposed string line shall be picked up and disposed of at the end of each day's paving. Paving shall not commence until the plan has been approved in writing by the Engineer.

The joints in the top layer of pavement shall be located as follows unless otherwise approved in writing by the Engineer:

For two lane roadways, offset six (6) to 12 inches from the center of pavement and from the outside edge of the travel lanes.

For roadways of more than two (2) lanes, offset 6 to 12 inches from lane lines and outside edge of travel

lanes.

Longitudinal joints shall not cross the centerline, lane lines or edge line unless approved by the Engineer.

Where paving operations are on the present traveled roadway, the Contractor shall arrange paving operations so there will be no exposed longitudinal joints between adjacent travel lanes longer than 25 feet at the end of a day's run. With the approval of the Engineer, the Contractor may be permitted to:

Leave a vertical exposed longitudinal joint when the thickness of the pavement course being placed is 1.5 inches or less.

Leave an exposed longitudinal joint when the thickness of the pavement course being placed is greater than two (2) inches provided that the top one (1) inch of the longitudinal joint shall be vertical. The remainder of the joint, below one (1) inch vertical portion, shall be tapered. The minimum width of the taper shall be two times the remaining thickness of the pavement course.

In the methods listed in paragraphs (1) and (2) above, all contact surfaces shall be given a tack coat of bituminous material before placing any fresh APM against the edge.

Transverse Joints

Along with the longitudinal joint plan, the Contractor shall submit a transverse joint plan showing the locations and the methods to be used to construct transverse joints. The Engineer must approve such plans prior to paving. Placing of the APM shall be continuous with a minimum of transverse joints.

Rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints just before additional mixture is placed against the previously compacted material.

The end of transverse joints shall be located so they will be constructed with a full head of mix in front of the screed. When butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted.

When a tapered joint is required for traffic access, the ramp shall be removed back to a full depth before paving is restarted.

When restarting paving operations, the paver screed shall be placed on starter blocks on the completed side of the transverse joint. The starter blocks should be approximately 25 percent of the thickness of the existing completed mat, so that adequate grade and compaction can be achieved on starting the paving operation.

Compaction

The APM shall be compacted by rolling. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continuous until the required density is obtained. When the mixture contains unmodified asphalt binder (PG 58-28 or PG 64-22), and the surface temperature falls below 185°F, further compaction effort shall not be applied unless the contractor can demonstrate no damage to the surface of the asphalt pavement. If the mixture contains modified asphalt cement (PG 76-28 or PG 64-28) and the surface temperature falls below 230°F, further compaction effort shall not be applied

unless the contractor can demonstrate no damage to the surface of the asphalt pavement. (Asphalt Pavement section).

Roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted during surface course final rolling and will not be permitted on any bridge decks covered with waterproofing membrane.

Pavement shall be compacted to a density of 94% (± 2%) of the maximum theoretical density, of the approved JMF. Field density determinations will be made in accordance with CP 44 or CP 81 (see Table 4.08). Core samples and compaction testing locations shall include a representative sampling (20% - 30%) of tests taken at 12 inches from visible joint lines for one lift paving and 18 inches from visible joint lines for multiple lift paving, for both longitudinal and transverse joints, to verify correlation between mat density and joint density. The joint density requirement shall be a minimum of 90 percent of the maximum theoretical density. If nuclear density measurements indicate results outside the tolerance limits, cores shall be used to verify results.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers. Locations too narrow for mechanical tampers shall be compacted with a hand tamper to achieve the best density.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture, and compacted to conform to the surrounding area.

Testing and Inspection

Process Control (PC)

For the purposes of this Specification, PC is defined as the program employed by the APM Supplier and Paving Contractor (“Contractor”) for controlling the production and installation of APM pavements in compliance with this Specification and industry standards. PC of the work will be based on the implementation of the Contractor's Process Control Plan, on the results of PC testing, and on the following characteristics of the APM and the completed pavement:

Binder Grade Certification
Asphalt Binder Content
Aggregate Gradation
Air Voids
Voids in the Mineral Aggregate (VMA)
Mat Density
Mat Thickness
Mat Smoothness
Lottman Tensile Strength

Process Control (PC) testing shall typically be performed by the APM Supplier/Paving Contractor using the APM Supplier’s lab. PC testing shall include both the plant-produced materials as specified in Tables 4.06 and 4.07, and the field-placed material as specified in Table 4.08. Test results from each day's production shall be completed and submitted as soon as possible to the owner/agency engineer’s representative. Failing PC test results shall be reported within one (1) business day.

Testing facilities shall conform to AASHTO requirements, including R-18. Personnel performing sampling and testing of APM, in the lab and in the field, shall possess the appropriate and current LabCAT certification or combination of certifications, issued by the Rocky Mountain Asphalt Education Center for all sampling and testing performed.

Owners Acceptance (OA)

For the purposes of this Specification, OA is defined as the program employed by an Owner/Agency, for assuring compliance with this Specification and industry standards, for ensuring that the Contractor's PC program is functioning properly, and for accepting the finished AMP pavement product. Developers as interim owners provide the OA testing on development projects.

The owner/agency reserves the right to conduct Owners Assurance (OA) testing on all features of the APM production and paving operations. The owner/agency will pay for passing OA tests on City/County contracts. The Developer will pay for passing OA tests on development projects. Failing tests and required retests and corrective actions will be paid for by the Contractor, if sampling and testing are performed in accordance with proper procedures. The cure for failed testing is at the discretion of the owner/agency, and may include removal and replacement, deductive change order, or extended warranty with financial assurance.

OA of the work will be primarily based on the following characteristics of the APM and the completed pavement:

Asphalt Binder Content
Aggregate Gradation
Mat Density (Including Joints)
Mat Thickness
Mat Smoothness

VMA/volumetric OA testing will normally be reserved for larger jobs (greater than 5000 tons) and utilized at the discretion of the owner/agency by special provision and include a check test program in accordance with CP-13.

OA tests will be performed by either an Independent Testing Lab or by an owner/agency laboratory. Testing facilities shall conform to AASHTO requirements, including R-18. Personnel performing testing, in the lab and in the field, shall possess the appropriate and current LabCAT certification or combination of certifications issued by the Rocky Mountain Asphalt Educations Center (RMAEC) for all testing performed. Failing OA test results shall be provided to the Contractor/Developer and APM Supplier within one (1) business day.

Testing Responsibilities

Capital Projects and Overlays For capital projects, overlays, and similar projects that are managed directly by contracts between the owning agency and general contractors, paving contractors and/or APM suppliers.

Process Control (PC) In general, PC for overlays and capital projects will be managed by the APM Supplier or Paving Contractor, primarily using the APM Supplier's lab.

Owners Acceptance (OA) The Owner will augment the Contractor's PC program by providing an independent testing laboratory for the required testing frequencies as specified in Table 4.08 – "Field Acceptance Testing", or as specified in the contract. Additional OA tests on both plant-produced materials and field-placed materials may be ordered by the Owner's representative from an independent testing laboratory at any time as deemed necessary by the Owner's project manager.

Development Projects

PC For development projects, PC testing will be performed by the Contractor. The plant-produced APM will be tested by the APM Supplier's lab as specified in Tables 4.06 and 4.07. The field-placed material shall be tested by the Contractor's lab as specified in Table 4.08.

OA The plant-produced and field-placed material shall also be tested by an independent testing laboratory, as specified in Tables 4.06, 4.07, and 4.08, paid for by the Developer. The Developer may order additional testing as necessary to assure compliance with this Specification. Additional PA tests on both plant-produced materials and field-placed materials may also be ordered and paid for by the owner/agency's representative from an independent testing laboratory at any time deemed necessary by the owner/agency's representative.

Summary - Table 4.05 – "Testing Responsibilities" summarizes these requirements.

Testing Frequencies and Tolerances

Plant-Produced Material Sampling shall be at the plant. Sufficient material for preparation of test specimens shall be obtained by the Contractor in accordance with CP 41 and AASHTO T168, most recent. When the owner/agency chooses to conduct PA testing through an independent testing laboratory, samples obtained by the Contractor shall be split with the OA materials laboratory. One set of laboratory compacted specimens will be prepared for each at the number of gyrations required in Table 3.01. Each set of laboratory compacted specimens will consist of three test portions prepared from the same sample increment. The material shall be compacted in accordance with CP L-5115 at the temperature as specified in the JMF.

The testing of plant-produced material shall be in accordance with Table 4.06 and 4.07. Two consecutive gradation tests falling outside the Action Limits, or one gradation test falling outside the Suspension Limits, will warrant corrective action and shall be subject to engineering review and possible removal and replacement of the represented day's production.

The asphalt binder in the plant-produced material shall meet the specification in Table 2.06 – Properties of Performance Graded Binders, for the binder grade specified.

TABLE 4.05
TESTING RESPONSIBILITIES

SAMPLING LOCATION	TESTS	PC		OA	
		Capital Projects & Overlays	Development Projects	Capital Projects & Overlays	Development Projects [1]
PLANT - PRODUCED MATERIALS Supplier's lab as specified in Tables 4.06 and 4.07.	Asphalt Binder Grade Certification	Refinery	Refinery	Refinery	Refinery
	Liquid Anti-Strip Certification	Refinery	Refinery	Refinery	Refinery
	Asphalt Binder Content	APM Supplier	APM Supplier	Owner/Agency or Ind. Lab	Independent Testing Lab
	Aggregate Gradation	APM Supplier	APM Supplier	Owner/Agency or Ind. Lab	Independent Testing Lab
	Air Voids	APM Supplier	APM Supplier	NA[2]	NA[2]
	Voids in Mineral Aggregate (VMA)	APM Supplier	APM Supplier	NA[2]	NA[2]
	Lottman Tensile Strength	APM Supplier	APM Supplier	Independent Testing Lab	Independent Testing Lab
FIELD - PLACED MATERIALS The Contractor's lab as specified in Table 4.08.	Asphalt Binder Content	APM Supplier	APM Supplier	Owner/Agency or Ind. Lab	Independent Testing Lab
	Aggregate Gradation	APM Supplier	APM Supplier	Owner/Agency or Ind. Lab	Independent Testing Lab
	Mat Density (% Compaction)	APM Paving Contractor	APM Paving Contractor	Owner/Agency or Ind. Lab	Independent Testing Lab
	Mat Thickness	APM Paving Contractor	APM Paving Contractor	Owner/Agency or Ind. Lab	Independent Testing Lab
	Mat Smoothness	Paving Contractor	Paving Contractor	Owner/Agency Inspector	Owner/Agency Inspector

[1]Independent Testing Lab hired by the Developer.
[2]Unless addressed in the contract.

TABLE 4.06
PLANT PC TESTING FREQUENCIES AND TOLERANCES [1]

Test	Current Procedure	Specification Tolerance Limits	Frequency
Asphalt Binder Content	CP-L 5120	± 0.4%	1 per 1000 tons [2] or 1 per day min.
Aggregate Gradation	CP 31	Table 4.07	1 per 1000 tons [2] or 1 per day min.
Air Voids	CP 44	+/-1.2%	1 per 1000 tons [2, 3] or 1 per day min.
Void in Mineral Aggregate	CP 48	+/-1.2%	1 per 1000 tons [2, 3] or 1 per day min.
Lottman Tensile Strength	CP-L 5109	70 min.	1 per mix design in first month of production

[1]Subject to owning agency engineer's direction on a job-by-job basis.

[2]The frequency of testing shall be based on *cumulative tonnage* of all projects using the approved JMF. Representative tests for each mix design may be used for multiple jobs. Testing for less than 500 cumulative tons per day is not required.

[3]Upon verification in accordance with Section 3, air voids and VMA testing frequency may be 1 per 10,000 tons or 1 per week minimum.

TABLE 4.07
CONTROL LIMITS FOR AGGREGATE MEASUREMENTS

Sieve	Action Limit	Suspension Limit
1 in.	0%	0 %
¾ in.	±6%	± 8 %
½ in.	±6%	± 8%
⅜ in.	±6%	± 8 %
No. 4	±5%	± 7 %
No. 8	±5%	± 7 %
No. 30	±4%	± 6 %
No. 200	±2%	± 3 %

When 100% passing is designated, there shall be no tolerance. When 90-100% passing is designated, 90% shall be the minimum; no tolerance is used.

Field-Placed Material - Sampling for Asphalt Binder Content and Aggregate Gradation shall be taken by the PC representative, preferably at the plant in accordance with CP41 or AASHTO T168, or at the job site in accordance with CP41, and witnessed by an authorized representative of the owner/agency. APM pavement shall be tested in-place for acceptance in accordance with Table 4.08.

Acceptance will be based on PC tests provided by the APM Supplier/Paving Contractor and verified by OA testing by Independent Testing Laboratories as required by this Specification and the owner/agency representative.

When nuclear density measurements are allowed by the owner/agency representative for acceptance of field placed material, they shall be taken in accordance with CP 81. The nuclear density gauge shall be correlated to a minimum of six (6) cores taken from the same material. If nuclear density measurements indicate results outside the tolerance limits, cores shall be used to verify results. Size of the project should be considered when determining the basis for the density test correlation. Small quantities of APM are not applicable to CP 81 procedure.

Core samples shall be neatly cut with a core drill or other approved equipment. The minimum diameter of the sample shall be four inches. Defective samples, because of sampling, shall be discarded and another sample taken. Cores shall not be taken closer than one foot from a transverse joint, longitudinal joint, edge of roadway, or concrete surface The Contractor installing the pavement shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. The Contractor shall be responsible for supplying the Owner's materials laboratory with the core samples. Cored holes shall be filled with plant generated APM, in a manner acceptable to the owner and within one day after sampling.

Test results of the percent of maximum theoretical density (density) shall be determined by dividing the density reading of the nuclear density gauge or core by the maximum density of the product as determined by the approved JMF. Testing frequency for percent of maximum theoretical density shall be in accordance with Table 4.08.

The required compacted APM mat thickness shall be as specified on the construction plans and/or specified in the Special Conditions.

For development projects, the final mat thickness shall be determined from the same cores as are used to test for density. No single core thickness shall be less than ninety percent (<90%) of the specified thickness on the construction plans and/or Special Conditions. When a single core thickness is less than ninety percent (<90%) of that specified, or when the job average is less than the specified design thickness, the Contractor shall correct the situation at his expense.

For capital projects, the yield calculation shall be used to calculate the average thickness and shall be based on 94% of the JMF Rice value. The calculated average thickness must be greater than or equal to the design thickness, the Contractor shall correct the situation at his expense.

Surface Smoothness of the final riding surface of all pavements is subject to testing by the 10-foot straightedge method. The Contractor shall furnish an approved 10-foot straightedge and depth gauge and provide an operator to aid the Engineer in testing the finished pavement surface. Areas to be tested shall be determined by the Engineer or the owner/agency inspector. The variation between any two contacts with the surface shall not exceed 3/16-inch in 10 feet. Areas showing deviation of more than 3/16-inch shall be marked and corrected at the Contractor's expense.

TABLE 4.08
FIELD ACCEPTANCE TESTING

FIELD ACCEPTANCE TESTING Test	Current Procedure	Specification Tolerance Limits	Frequency
Asphalt Binder Content	CP-L 5120	± 0.4 %	1 per 1,000 tons, or 1 per day minimum[2]
Aggregate Gradation	CP 31	See Table 4.07	1 per 1,000 tons, or 1 per day minimum[2]
Mat Density (% of Maximum Theoretical Density by the approved JMF Rice)	CP 44 or CP 81	94% ± 2%	1 per 500 tons, or portion thereof [1]
Mat Thickness Development Capital Projects[3]	 Core Measurement Yield Calculation	 Design minus 10% on a single test. Job average must be ≥ design thickness. The calculated average thickness must be ≥ design thickness.	 Development: 1 per lane every 1,000 feet, or portion thereof. Cores shall be taken within 5 business days of placement. By the developer's geotechnical engineer. Calculated Daily
Longitudinal Mat Smoothness (with no grade changes present)	10-ft Straightedge	≤ 3/16-inch	At Owner/Agency Inspector's discretion

[1]Longitudinal joints shall be tested at 20% - 30% of the total number of compaction tests taken, with a minimum of at least one per job.
[2]The frequency of testing shall be based on cumulative tonnage of all projects using the approved Job Mix Formula. Representative tests for each mix design may be used for multiple jobs. Testing for less than 500 cumulative tons per day is not required.
[3]Coring for thickness may be required at the discretion of the owner/agency in the project specifications or if yield calculations indicate a potential discrepancy with the thickness.

Contractors' Process Control Program

The Asphalt Producers and the Installing Contractors shall develop Process Control (PC) Programs. The PC programs shall address all elements which affect the quality of the pavement including, but not limited to:

Mix Design
Stockpile Management
Plant Operations
Transportation
Placing and Finishing
Tack Coat Application Dilution Rate
Mat Density
Surface Smoothness
WMA Process and Placement Control (if needed)

Testing Laboratory - The Contractor shall provide a fully equipped asphalt testing laboratory or shall hire an independent testing laboratory for process control testing. Laboratory facilities shall be kept clean, and

all equipment shall be maintained in proper working condition and calibrated as required. The Owner's designated representative shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness process control activities. The Owner's representative will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, testing personnel and testing procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

Process Control Testing - The Contractor shall develop a Process Control testing plan and perform all process control tests necessary to control the production and construction processes applicable to these specifications. Process control test results shall be submitted to the Engineer within 24 hours of sampling. Personnel performing sampling and testing of aggregates or APM mixtures in the lab and in the field shall possess the appropriate LabCAT certification or combination of certifications issued by the Rocky Mountain Asphalt Education Center for all sampling and testing performed.

Test procedures for PC testing are shown in Tables 4.06 and 4.08.

The process control testing plan shall include, but not necessarily be limited to, the following tests:

Asphalt Binder - Asphalt content tests shall be performed for determination of binder content and shall be sampled at the same time as the VMA and air voids samples are obtained.

Air Voids and VMA - Air Voids and VMA shall be tested in accordance with CP 44 and CP 48, respectively, at a frequency in accordance with Table 4.06.

Gradation - Aggregate gradations shall be determined from mechanical analysis of extracted aggregate. When binder content is determined by a nuclear method, aggregate gradation shall be determined from the cold feed on drum mix or continuous mix plants or from hot bin samples on batch plants. The samples shall use actual batch weights to determine the combined aggregate gradation of the mixture.

Lottman Tensile Strength - One sample per mix design during the first month of production, and as necessary for control thereafter.

Moisture Content of Aggregate - The moisture content of the aggregate used for the production shall be determined in accordance with AASHTO T 255.

Moisture Content of Mixture - The moisture content of the mixture shall be determined in accordance with CP 43 Method B.

Temperatures - Temperatures shall be checked, at least twice per day, at necessary locations to determine the temperatures of the dryer, the binder in the storage tank, the mixture at the plant and the mixture at the job site.

In-Place Density Monitoring - The Contractor shall conduct testing to ensure that the specified density is being achieved during the construction of the APM pavement.

Additional Testing - Any additional testing that the Contractor deems necessary to control the process may be performed at the Contractor's option.

Monitoring - The Engineer and/or the owner reserve the right to monitor any of the process control tests listed above and to perform verification sampling and testing of all materials.

Sampling - When directed by the Engineer, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced, or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

Control Charts - The Contractor shall maintain linear control charts both for individual measurements and ranges (i.e., difference between highest and lowest measurements) for aggregate gradation and asphalt content.

Method of Measurement

The accepted quantities of APM will be measured by the units specified in the contract for each bid item. Batch mass (weights) will not be permitted as a method of measurement.

If there is a no pay item for APM of the specified, it will not be measured and paid for separately, but shall be included in the pay item most closely associated with the work.

Basis of Payment

The accepted quantities of APM pavement will be paid for at the contract unit price for each pavement type and/or thickness listed in the bid schedule. The price will be full compensation, furnishing all materials, preparation, mixing, placing, and compaction of these materials and for all labor, equipment, tools, safety edges, and incidentals necessary to complete the work.

Payment for tack coat shall be a separate bid item and shall include all materials, tools, equipment, and labor necessary to complete the work in accordance with the plans and specifications and as directed by the Engineer. Tack coat shall be paid for based on diluted gallons.

If there is no pay item for tack coat, it will not be measured and paid for separately but included in the APM payment item.

Appendix A, Prepaving Conference Agenda

Date			
Project Information			
Project/Subdivision Name:			
Construction Schedule	Approved as Submitted	Not Approved	Missing
Paving Date			
Required Permits	Traffic Control	Paving	Other
Notifications	Email	Mailers	
Locate Ticket Number			
Project Staff			
Agency Owner Representative			
Name		Agency	
Email		Contact Number	
Developer Representative			
Name		Company	
Email		Contact Number	
Paving Contractor Representative			
Contact Name		Company	
Email		Contact Number	
Traffic Control Representative			
Contact Name		Company	
Email		Contact Number	
Testing Agency Representative			
Contact Name		Company	
Email		Contact Number	
Pavement Design Information			
Approved Pavement Report	Yes	No	N/A
Report/Project No.			
Subgrade Information	Chemical Treated	Aggregate Base	Other
Depth (inch)			
Asphalt Paving Material (s)		Agency Approved	
Additives	Fiber	WMA	
Amount/Type			
Lift Thickness (inches)	Bottom	Intermediate	Top

Field Testing			
Testing Scheduling Responsibility			
Name		Company	
Testing Scheduling Number or email			
Guage Information	Calibrated Date	Correlation Date	Guage Correction Factor
PC			
OA			
Field			
Mat Density			
(% Compaction by the approved JMF Rice)	JMF - Rice	Joints	Mat
Thickness	Yield	Coring	
Longitudinal Mat Smoothness (with no grade changes present)			
Sample Collection	OA	PC	Other
Field Test Report Information Provided to			
Name		Number	
Laboratory			
	Date	Whom	Notes
Laboratory Inspection			
Laboratory Equipment Calibration Information			
Testing			
Asphalt Binder Content			
Aggregate Gradation			
Air Voids			
Voids in Mineral Aggregate (VMA)			
Lottman Tensile Strength			
Documentation			
Reports			
Owner Agency			
Name		Email	
Contractor			
Name		Email	