



CITY OF COLORADO SPRINGS

DATE: December 29, 2006
TO: Engineers, Contractors, Developers and Other Interested Parties
FROM: Cam McNair, PE, City Engineer *Cam McNair*
SUBJECT: Pikes Peak Region Asphalt Paving Specifications

In accordance with the authority granted the City Engineer in City Code Section 3.3.102, the recently developed *Pikes Peak Region Asphalt Paving Specifications* is adopted for application on all asphalt paving projects in the City of Colorado Springs, effective January 1, 2007.

The City of Colorado Springs Public Works Department and the El Paso County Department of Transportation have worked for over two years in cooperation with the Colorado Asphalt Pavement Association (CAPA) and its member asphalt paving contractors to develop this new specification. This 30-page document is intended to establish a uniform, consistent asphalt paving specification for use throughout the City, unincorporated El Paso County, and eventually throughout the Pikes Peak Region. The complete document is available on the City Engineering website at:

<http://www.springsgov.com/units/cityeng/PikesPeakRegionalAsphaltPavingSpecsfinaldraft100906.pdf>

Hard copies of the document as well as CDs can be purchased at City Engineering for a nominal charge.

Key Highlights:

- The specification is intended to reduce or possibly eliminate the differences in asphalt paving specifications from agency to agency and establish a uniform, consistent asphalt paving specification for use in the Colorado Springs/El Paso County area.
- Development started in 2004 and will be in place for 2007 construction for City of Colorado Springs projects, El Paso County projects, PPRTA projects, and development work. It is hoped that other agencies adopt the specification in the future (Teller County, Park County, Fountain, Manitou Springs, Green Mountain Falls, Monument, etc.).
- Specification development was a cooperative effort between the Colorado Asphalt Pavement Association, its Colorado Springs area members, the City of Colorado Springs – City Engineering and Streets Divisions, and the El Paso County Transportation Department.
- The specification reduces the potential number of different mixes in approximately half of what was previously used.

- Latest industry standards and CDOT requirements of SUPERPAVE mixes were included in the specification. This ensures that high quality asphalt binder, sand and aggregate are used.
- The specification allows 20% recycled asphalt pavement (RAP), includes a joint density requirement, a plant produced mix verification requirement, and an independent lab testing requirement for development work. A frequency of quality control and quality assurance testing has been developed that is based on cumulative tonnage of all projects using the same mix design.
- The specification includes a guideline Hot Mix Asphalt Pre-paving Conference Agenda (Appendix A), and an easy-to-use material check off form (Appendix B).
- It is expected that the members of the development group (i.e., City of Colorado Springs, El Paso County, and CAPA members and staff) will reconvene after the 2007 construction season and evaluate any changes that should be considered.

The City of Colorado Springs is delighted to make this step forward in terms of improved quality of construction and maintenance on our asphalt-paved streets. We also welcome comments and suggestions for improving the specification. Please direct your questions and/or comments to Jerry Banks, Engineering Programs Manager, (719)385-5407, or jbanks@springsgov.com.

cc: Rob MacDonald, PPACG Executive Director
John McCarty, El Paso County Director of Transportation
Lorne Kramer, City Manager
Greg Nyhoff, Assistant City Manager
Ron Mitchell, Public Works Director
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SECTION 430

CONCRETE PAVEMENT

431 Description

The work performed under this section shall consist of the construction of a pavement composed of Portland cement concrete, with or without reinforcement as specified, on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established.

432 Materials Specifications

432.01 General

The specifications presented in this section are performance oriented. The City's objective in setting forth these specifications is to achieve an acceptable quality of streets. All sources for the mined or manufactured materials listed in Section 432.05 must be annually approved by the City as having met the appropriate materials performance specifications. This approval is a condition of using those material sources for public improvement construction.

432.02 Procedure For Material Source Approval

On or before April 1st of each year, a material supplier for any City improvement shall supply written documentation and material test results from a qualified, independent materials testing laboratory that describes:

1. Material(s) being tested to meet City specifications.
2. The test procedures employed.
3. The supplier(s) manufacturing, mining or treating process by which the tested materials were created.
4. The material test results.
5. A signed statement by the material supplier that the materials produced and tested for this certification are truly representative of the materials to be provided for public improvements in the City during the coming 365 day period.

432.03 Violations of Approval Conditions

Random Testing. The Engineer may order random tests of materials used in City improvements to verify compliance with the material specifications. These tests are in addition to the requirements of Section 434 of this Chapter.

432.04 Use of Materials Not Listed in Section 432.05

Materials listed in this section and provided with a set of specifications are those deemed by the City to be the primary structural materials commonly or typically used in public improvements. Ancillary public improvement materials such as manufactured paints and coatings, bonding agents, sealers, gaskets, insulating materials, etc. should be in compliance with Colorado Department of Highways material specifications for the appropriate material employed. Alternative materials for construction may be proposed for use. Decisions on acceptability of alternative materials will be made by the Engineer.

432.05 Portland Cement Concrete

This material shall consist of a mixture of fine and coarse aggregates, Portland cement, water and other materials or admixtures as required.

- A. Portland cement shall comply with the Colorado Department of Highways requirements and ASTM C-150, C-175 or C-595. The type of cement shall be Type IIA (air entraining) or Type V, unless sulfate conditions allow otherwise. Table 2.2.3 in Chapter 2.2 of ACI 201 presents cements recommendations for sulfate resistances. In addition to the standard chemical requirements for Portland cement in ASTM C-150, the maximum percent of alkalis shall be as specified in Table 2 of ASTM C-150 for low-alkali cement. Other types of cement or admixtures are only to be used upon approval by the Engineer.
- B. Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. Fine aggregate shall meet Colorado Department of Highways Section 703.01 requirements and gradation, except as shown in the Table below.

| FINE AGGREGATES FOR PORTLAND CEMENT CONCRETE | |
|---|--|
| Sieve Size or Test Procedure | Percent Passing or Test Requirement |
| 3/8" | 100 |
| No. 4 | 95-100 |
| No. 16 | 45-80 |
| No. 50 | 10-30 |
| No. 100 | 2-10 |
| No. 200 (AASHTO T-11) | * 3.0 Max. |
| Clay Lumps & Friable Particles,% (AASHTO T-112) | 3.0 Max. |
| Coal & Lignite, %, (AASHTO T-113) | 1.0 Max. |
| Deleterious Material, %, (AASHTO T-11) | 3.0 Max. |
| Sand Equivalent, %, (AASHTO T-176) | 75 Min. |
| Fineness Modulus | 2.50-3.50 |
| Sodium Sulfate Soundness, %, (AASHTO T-104) | 10 Max. |

* 5.0 Max. for crusher fines

- C. Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, air cooled blast furnace slag, or crushed hydraulic-cement concrete, or a combination thereof, conforming to the requirements of this specification. Coarse aggregate shall meet Colorado Department of Highways Section 703.02 requirements and gradation, except as shown in the Table below.
- D. Fly ash only to be used on a case-by-case basis when approved by the Engineer.
- E. Portland cement will be accepted on the basis of certificates of compliance and ASTM-C-150. Reinforcing steel, dowel sand tie bars will be accepted by certificate of compliance and mill reports. Water, if not potable, shall be sampled and tested before use. Water shall meet the requirements of Colorado Department of Highways Section 712.01. Only Colorado Department of Highways approved brands of air entraining agents, chemical admixtures and curing materials may be used and must be documented.

- F. Calcium chloride shall not be used as an admixture in concrete. Admixtures used in prestress or bridge deck concrete shall meet the chloride limitations of ACI 201 for total chloride in concrete.
- G. The curing compound shall be a white pigmented liquid membrane forming curing compound and meet the requirements of AASHTO M-148. The curing compound shall be applied under pressure at the rate of one gallon to not more than 150 square feet by mechanical sprayers.

| COARSE AGGREGATES FOR PORTLAND CEMENT CONCRETE | |
|---|--|
| Sieve Size or Test Procedure | Percent Passing or Test Requirement |
| 2" | 100 |
| 1-1/2" | 95-100 |
| 3/4" | 35-70 |
| 3/8" | 10-30 |
| No. 4 | 0-5 |
| No. 200 (AASHTO T-11) | * 1.0 Max. |
| ----- | |
| % Wear (AASHTO T-96) | 45 Max. |
| Clay Lumps & Friable Particles, % (AASHTO T-112) | 5.0 Max. |
| Coal & Lignites, %, (AASHTO T-113) | 0.5 Max. |
| Sum of Clay lumps, Friable Particles and Chert, (AASHTO T-11) | 7.0 Max. |
| Sodium Sulfate Soundness, %, (AASHTO T-104) | 12 Max. |

* 1.5 Max. for crusher fines

NOTE: AASHTO M-43, Size No. 57 may also be used on a case-by-case basis when approved by the Engineer.

- H. Reinforcing steel shall meet the requirements of Colorado Department of Highways Section 709.01, grade 40 minimum.
- I. Proportioning - Minimum laboratory trial mix strength shall be 600 psi (third point flexural) at age 28 days (ASTM C-78). A minimum of 6 test cylinders shall also be taken of the laboratory mix for future correlations (ASTM C-39).

Cement - 564 lbs. minimum per cubic yard of concrete

Air Content - 6% ($\pm 1-1/2\%$)

Slump - 3 inch maximum (may be increased to 4 inches for hand work).

Water/Cement Ratio - 0.45 maximum

433 CONSTRUCTION REQUIREMENTS

Materials shall be proportioned, handled, measured, batched, placed, finished and cured in accordance with Section 412 of the Colorado Department of Highways Specifications and ASTM C-94 (whichever is more stringent).

434 QUALITY CONTROL

All samples and tests described herein shall be made in accordance with approved ASTM/AASHTO procedures. The owner/developer shall provide for all testing laboratory services in connection with tests verifying conformance of proposed materials with project requirements. The owner/developer shall also provide for testing laboratory services in connection with tests on materials after incorporation into the project, on a first time basis only. The costs of any retesting, as required, shall be borne by the Contractor.

During placement of Portland cement concrete pavement, observation and testing shall be on a full-time basis. For each day of production, aggregate samples shall be obtained for gradation of both the coarse and fine aggregates.

Slump, air content, unit weight and mix temperature shall be tested for each set of cylinders taken. The first three loads shall be tested for slump and air content. If any one test fails to meet requirements, that load shall be rejected and tests shall continue on each load until three consecutive loads meet requirements. Thereafter, slump, air content, unit weight and mix temperature shall be tested at least every 100 cubic yards. Any load not meeting test specifications shall be rejected.

Five compressive strength cylinders shall be fabricated for each 100 cubic yards or major fraction thereof on each day pavement is placed. Cylinders shall be tested as follows: 2 at 7 days, 2 at 28 days and 1 at a later date, if necessary, as required by the Engineer.

Thickness of fresh concrete must be checked a minimum of every 300 lineal feet each traffic lane according to the Colorado Department of Highways Section 412.24. Any noted deficiency areas shall be corrected at that time. Surface deficiency areas shall also be corrected at that time. Surface smoothness shall be tested and corrected as necessary according to Colorado Department of Highways Section 412.16. The Engineer will decide when the pavement shall be opened to traffic; otherwise the pavement shall not be opened to traffic until 14 days after the concrete was placed, or until the compressive strength of laboratory cured 6 x 12 cylinders (ASTM C-39) averages 3000 psi. Prior to opening to traffic, the pavement shall also be cleaned and all joints sealed.

435 FINAL ACCEPTANCE

All test results shall be submitted and reviewed by the City. Provided all tests are acceptable, the pavement will be accepted. Should testing indicate unsatisfactory work, removal, replacement, grinding or reduced payment will be required.

436 MEASUREMENT AND PAYMENT

The accepted quantities of concrete pavement will be paid for at the contract unit price per square yard which price and payment shall be full compensation for furnishing and placing all materials, including any dowels, tie bars and joint material, provided, however, that for any pavement found deficient in thickness by more than 0.20 inch, but not more than 1.0 inch, only the reduced price stipulated below shall be paid.

No additional payment over the unit contract bid price will be made for any pavement which has an average thickness in excess of that shown on the plans. Reinforcing steel, other than as mentioned above, will be measured and paid for in accordance with the Colorado Department of Highways Section 602.

Where the average thickness of pavement is deficient in thickness by more than 0.20 inch, but not more than 1.0 inch, payment will be made at an adjusted price as specified in the following table.

| CONCRETE PAVEMENT DEFICIENCY | |
|---|--|
| Deficiency in Thickness (Determined by Cores) INCHES | Proportional Part of Contract Price Allowed |
| 0.0 to 0.20 | 100% |
| 0.21 to 0.30 | 80% |
| 0.31 to 0.40 | 72% |
| 0.41 to 0.50 | 68% |
| 0.51 to 0.75 | 57% |
| 0.76 to 1.00 | 50% |
| Over 1.00 | NONE |

When the thickness of pavement is deficient by more than one inch, and judgement of the Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.



Pikes Peak Region

Asphalt Paving Specifications



Pikes Peak Region Asphalt Paving Specifications *

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* Substitute this spec for Part III, Section 1, of CAPA’s “ Guide Contract Documents and Specs for HMA Construction” when applied to projects in Colorado Springs and El Paso County

Pikes Peak Region Asphalt Paving Specifications

1.001 General Description. These specifications cover the requirements for the construction of Superpave Hot Mix Asphalt pavements. They include the general requirements for the construction of one or more lifts of Hot Mix Asphalt Pavement on a prepared surface. The work shall consist of the preparation of the Hot Mix Asphalt (HMA) meeting the requirements herein, and the placement of the HMA to the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer. When more than one lift is required, each lift shall be compacted to the required density prior the placement of the next lift.

In these specifications the following terminology listed in Table 1.001.1 defines the traffic and volume levels for the different designations.

TABLE 1.001.1 - TRAFFIC AND VOLUME DESIGNATION

| Designation | Volume and Loading Level |
|---------------------|---|
| Low | ≤ 300,000 ESALs * |
| Moderate | > 300,000 to ≤ 10,000,000 ESALs |
| High | > 10,000,000 ESALs |
| Trails and Pathways | < 100,000 ESALs - able to accommodate a 4000 lb vehicle for safety and maintenance purposes |
| Parking Lots | 25 % of volume used for entrance roadways |

* Equivalent Single-Axle Loads

1.002 Materials. The HMA shall be composed of a mixture of aggregate, approved filler or additives, asphalt binder and reclaimed asphalt pavement (RAP), when permitted. The materials used in the manufacture of HMA shall meet the following requirements.

A. 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 1.002.1.

The coarse and fine aggregates for the hot mix asphalt mixture shall be graded and combined in such proportions that the resulting composite blend meets the grading requirements of the job mix formula. The following gradation Table 1.002.1 is for identification of material for bidding purposes only.

Aggregates meeting the requirements in Table 1.002.1 shall be used to develop the Job Mix Formula (JMF) for the HMA mixture. The aggregate should be composed of angular, coarse textured, cube shaped particles. Excess of fine material shall be wasted before crushing. Natural sand may be used to obtain gradation of the blended aggregate mixture but should not exceed 25%. If the percent of aggregate passing the #4 sieve is greater than 10% by weight of the individual aggregate sample, Plasticity will be determined in accordance with AASHTO T 90. The gradation of the aggregates used in the mixture shall meet the criteria shown in the Aggregate Master Range Table 1.002.2, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine. The nominal size aggregate used in the HMA mixture shall not be more than one-third the thickness of the uncompacted HMA lift being constructed.

TABLE 1.002.1 - AGGREGATE PROPERTIES

| Property | Test Procedure | Coarse Retained on #4 Sieve | Fine Passing the #4 Sieve |
|---|---------------------------------|-----------------------------|--------------------------------------|
| Fine Aggregate Angularity ³ | CP ¹ -L5113 Method A | | 40% Minimum |
| Traffic Level Low, Moderate, Trails and Pathways | | | 45% Minimum |
| Traffic Level 3 to 5 Moderate, High, Parking Lots | CP-45 | 70% Minimum | |
| Fractured Faces (minimum of 2) | AASHTO ² T 96 | 45% Maximum | |
| LA Abrasion | AASHTO M 283 | 10% Maximum | |
| Flat and Elongated Pieces | | | 12% Maximum Combined Coarse and Fine |
| Sodium Sulfate Soundness | AASHTO T 104 | | |
| Sand Equivalent ³ | AASHTO T 176 | | 45% Minimum |

¹CP designates Colorado Department of Transportation material Testing Procedures

²AASHTO designates American Association of State Highway and Transportation Officials Testing procedures

³Tests are for the combined or blended samples.

TABLE 1.002.2 - AGGREGATE MASTER RANGE FOR HOT MIX ASPHALT MIXTURES

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

*These additional screens will be established for the Contractor's Quality Control Testing using values from the Mix Design gradation.

B. 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 1.002.3. The maximum amount of allowable hydrated lime or hydraulic cement shall not exceed 3% by weight of mix.

TABLE 1.002.3 - MINERAL FILLER GRADING LIMITS

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

C. Additives. Additives to the mineral aggregate shall be added if the asphalt binder will not coat or stick to the aggregates. Additives shall be either Hydrated Lime, or other Anti-stripping Agents as approved by owner / agency engineers.

1. Hydrated Lime. Hydrated lime shall conform to ASTM C 207, Type N. The residue retained on a #200 (75µm) sieve shall not exceed 10% when determined in accordance with ASTM C 110.

2. Anti-stripping Agent. Liquid Anti-strip Agent shall be submitted for review and approval by owner.

D. Reclaimed Asphalt Pavement. Reclaimed Asphalt Pavement (RAP) shall be allowed in the HMA mixture. It shall be of uniform quality and gradation with a maximum size particle no greater than the maximum size allowed in the HMA mixture. HMA mixtures containing RAP shall meet the same gradation requirements as a virgin HMA mix. Hot Mix Asphalt pavements shall not contain more than 20% reclaimed asphalt pavement, unless approved by the owning agency's engineer. In no case shall the RAP exceed 25%. The reclaimed asphalt pavement shall meet all the requirements for HMA pavement, as contained herein.

Reclaimed Asphalt Pavement (RAP) Material: The Engineer may require the contractor to maintain separate stockpiles for each type of RAP material. All processed material shall be free of foreign 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.

E. Asphalt Binder. Recommended Performance Graded asphalt binders are listed in Table 1.002.4, Binder Grades for HMA mixtures, and shall meet the requirements listed in Table 1.002.5, Properties for Performance Graded (PG) Binders. Any asphalt binder supplied must be from an approved source. An approved source for asphalt binders has to be certified by the Colorado Department of Transportation.

TABLE 1.002.4 - BINDER GRADES FOR HMA MIXTURES

| Traffic Levels ¹ | | Binder Grades |
|-----------------------------|---------------------------------|-----------------------------------|
| Low | (< 300,000 ESALs) | PG 64-22 or PG 58-28 ² |
| Moderate | (300,000 to ≤ 10,000,000 ESALs) | PG 64-22 |
| High | (> 10,000,000 ESALs) | PG 64-22 or PG 64-28 ³ |
| Trails and Pathways | (< 100,000 ESALs) | PG 64-22 or PG 58-28 |
| Parking Lots | (25 % of Roadways) | PG 64-22 |

¹ For 20-Year Designs

² For elevations approximately 7000 feet or above, may use PG 58-28

³ As specified by the Engineer

TABLE 1.002.5 - PROPERTIES OF PERFORMANCE GRADED BINDERS

| Property | PG Graded Binder Requirements | | | | | AASHTO Test No. |
|--|-------------------------------|-------|-------|-------|--------------------|---------------------------------|
| | 58-34 ¹ | 58-28 | 64-22 | 64-28 | 76-28 ¹ | |
| Original Binder Properties | | | | | | |
| Flash Point Temperature, °C, minimum | 230 | 230 | 230 | 230 | 230 | T 48 |
| Viscosity at 135 °C, Pa-s, maximum | 3 | 3 | 3 | 3 | 3 | TP 48 |
| Dynamic Shear, Temperature °C, where G*/Sin @ 10 rad/sec ≥ 1.00 kPa | 58 | 58 | 64 | 64 | 76 | TP 5 |
| 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 |
| RTOF Residue Properties AASHTO T 240 | | | | | | |
| Mass Loss, percent maximum | 1 | 1 | 1 | 1 | 1 | T 240 |
| Dynamic Shear, Temperature °C where G*/Sin @ 10 rads ≥ 2.20 kPa | 58 | 58 | 64 | 64 | 76 | TP 5 |
| Elastic Recovery, 25 °C, percent minimum | | | | | 50 | CP L-2211 ² Method A |
| Ductility, 4 °C (5 cm/min) cm, minimum | | | | 25 | | T 51 |
| Pressure Aging Vessel Residue Properties, Aging Temperature 100 °C PP 1 | | | | | | |
| Dynamic Shear, Temperature °C where G*/Sin @ 10 rads ≤ 5000 kPa | 16 | 19 | 25 | 22 | 28 | TP 5 |
| Creep Stiffness, @ 60 s, test Temp. In °C | -24 | -18 | -12 | -18 | -18 | |
| S, maximum, MPa | 300 | 300 | 300 | 300 | 300 | TP 1 |
| m-value, minimum | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | TP 1 |
| Direct Tension, Temp. in °C, @ 1mm/min. where failure strain ≥ 1.0% | -24 | -18 | -12 | -28 | -18 | TP 3 |

¹ Special grades used for unique loading or climate conditions.

² CDOT Test Method

The Contractor shall provide to the Owner 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 engineer.

1. Mixture Binder Selection. The binder to be used in the HMA mixture will depend on the local traffic level and traffic conditions. Binder grade selection for the HMA mixture for different traffic levels is shown in Table 1.002.4 Binder Grades for HMA Mixtures.

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

F. Material Acceptance. Prior to the delivery of materials to the job site, the Contractor shall submit certification tests to the engineer, for his approval, showing all materials to be used on the project meet the appropriate specification. The certification shall show the appropriate test(s) for each material, the test results and a statement that the materials meet the appropriate specification. If the Engineer request samples of the materials for verification testing prior to and/or during the production of the HMA mixture, the Contractor shall deliver the requested materials to the owner's designated representative.

1.003 Hot Mix Asphalt Mixture Composition. The HMA mix shall be composed of well-graded aggregate, mineral filler, anti-stripping agent (if required and approved) and asphalt binder.

A. Mix Design. The Contractor shall submit the mix design (JMF) to the Engineer for his approval seven (7) days prior to the beginning of paving operations. The mix design(s) of each mixture(s) to be used on the project shall be approved prior to the start of any paving operation. The mix design(s) 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.

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

1. Source(s) of materials.
2. Aggregate gradation, specific gravity, source and description of individual aggregates and the final mixture blend.
3. Aggregate physical properties.
4. Source and grade of Performance Graded binder along with certification of binder.
5. Proposed JMF: aggregate and additive blending, final gradation shown on a 0.45 power graph, optimum binder content.
6. Mixing and compaction temperatures.
7. N_{ini} , and N_{des} ,
8. Mixture properties determined at the minimum of four binder contents and interpolated at optimum and graphs showing mixture properties versus binder content.
9. Anti-stripping agent - product name and manufacturer.
10. Percent of RAP if used in the mixture.

The mix design(s) shall meet the requirements of Table 1.002.2 Aggregate Master Range for Hot Mix Asphalt Mixtures, Table 1.002.4 Binder Grades of HMA Mixtures, Table 1.003.1 Superpave Mixture Properties and Table 1.003.2 Voids in Mineral Aggregate. The HMA mixture(s) will be designed for the traffic level, nominal aggregate size and binder grade designated or as specified in the Special Provisions.

TABLE 1.003.1 - SUPERPAVE MIXTURE PROPERTIES

| Test Property | Traffic Levels | |
|--|-------------------------------------|----------------------|
| | Low, Moderate, Trails, Parking Lots | High |
| Initial Gyration, N_{ini} (Information only) | 7 | 8 |
| Air voids @ N_{ini} | > 9.5 | > 11.0 |
| Design gyration, N_{des} | 75 ¹ | 100 ¹ |
| Hveem Stability, CP-L 5106 | 28 min. | 30 min. |
| Voids Filled w/Asphalt, VFA, MS-2 | 65 - 78 | 65 - 75 |
| Lottman, Tensile Strength Ratio, % retained CP-L 5109 (Optimum AC) | 80 min. ² | 80 min. ² |
| Lottman, Dry Tensile Strength, psi, CP-L 5109 | 30 min. | 30 min. |

¹ Unless otherwise specified by the Engineer

² Lottman requirement is 80 min. for mix design and 70 min. for field acceptance.

TABLE 1.003.2 - VOIDS IN MINERAL AGGREGATE

| Nominal Maximum Particle Size * | Minimum VMA - % | | |
|---------------------------------|----------------------|------|------|
| | Design Air Voids - % | | |
| | 3 | 4 | 5 |
| ½" | 13.7 | 14.7 | 15.7 |
| ¾" | 12.7 | 13.7 | 14.7 |
| 1" | 11.7 | 12.7 | 13.7 |

* The nominal maximum particle size is one sieve size larger than the first sieve to retain more than 10 percent

If the Contractor proposes to use RAP in the HMA mixture(s), the resulting mixture(s) must meet the same requirements as a mixture(s) that does (do) not contain RAP. The RAP shall be of uniform quality. The maximum size of the RAP shall be 1½" prior to the introduction into the mixer. The maximum aggregate size contained in the combination of RAP and new aggregate shall not exceed the maximum specified in Table 1.002.2.

B. Plant Mix Production Verification. Mixture(s) being produced by the plant shall be verified 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 1.003.3. If the mixture(s) has been 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 HMA mixture(s) shall be within the limits shown in Table 1.003.3.

TABLE 1.003.3 - HMA MIXTURE DESIGN VERIFICATION TOLERANCES

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

1.004 Hot Mix Asphalt Pavement Construction.

A. 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 quality control and quality acceptance (QC/QA) of the HMA pavement shall attend a pre-paving meeting to go over procedures and acceptance of the HMA pavement. The layout and QC 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.

B. Paving Schedule. The Contractor shall arrange the work in such a manner as to cause a minimum of 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. Traffic Control shall be paid for as specified in the contract documents.

C. Weather Restrictions. The HMA mixture shall be placed only on properly constructed surfaces that are dry, unfrozen surfaces and only when weather conditions allow for proper handling and compacting of the mixture. The HMA shall be placed in accordance with the temperature limits shown in Table 1.004.1 and only when weather conditions permit the pavement to be properly placed and compacted as determined by the Engineer. Placement and compaction of the HMA may be accomplished at temperatures less than that that shown in Table 1.004.1 when meeting the compaction requirements stated herein and obtaining approval from the controlling governmental agency.

TABLE 1.004.1 - HMA PAVEMENT PLACEMENT TEMPERATURE LIMITATIONS

| Paving Course | Thickness | Minimum Surface and Air Temperature °F |
|---------------|-----------|--|
| Surface | All | 50 * |
| Subsurface | < 3" | 40 |
| Subsurface | ≥ 3" | 35 |

* Polymer modified asphalt binder HMA surface mixes. Other asphalt binder HMA may be placed at a minimum of 40 °F temperature and rising. 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.

D. HMA Production Facilities. The HMA 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 thereunder.

1. Truck Scales. The HMA mixture 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.

2. Inspection of Plant. The Engineer or his authorized representative shall have access, at all times, to all areas of the plant for checking the adequacy of the equipment; inspecting the operation of the plant; verifying weights, proportions and material properties and checking the temperatures maintained in the preparation of the mixtures.

3. Storage Bins and Surge Bins. HMA mix may be stored provided that any and all characteristics of the mixture are not altered by such storage.

If the Engineer determines that 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 HMA mix be stored more than 60 hours.

E. Hauling Equipment. Trucks used for hauling HMA mixtures shall have tight, clean and smooth metal beds. To prevent the mixture from adhering to them, 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 that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

F. Placement Equipment. Pavers shall be self-propelled, with an activated screed assemblies, heated as necessary, to spread and finish the HMA mixture to the specified width, thickness, smoothness and grade shown. 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.

G. Compaction Equipment. All compaction equipment used on the project for obtaining the required density of the HMA pavement shall be self propelled vibratory, steel wheel or pneumatic tire type capable of obtaining the 92 to 96 percent 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 HMA 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.

H. Hot Mix Asphalt Mixture Production. The HMA mixture shall be produced in a plant meeting the requirements of Section 1.004 D. The dried aggregates and asphalt binder shall be combined in the plant in the quantities required to meet the job mix formula.

1. 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 refiner.

2. 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 a slurry or a dry form and then thoroughly mixed in an approved pug mill. The slurry shall contain a minimum of 70% water by weight. If dry hydrated lime is used, it shall be added to the wet aggregate at a minimum of 2% 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.

3. Preparation of the Hot Mix Asphalt Mixture. The heated and dried aggregates and the asphalt binder shall be combined by weight in the mixer in the amount specified by the job mix formula. 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 HMA mixture, for different asphalt binder grades, when discharged from the plant, shall be within the maximum and minimum limits shown in Table 1.004.2. The HMA mixture 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 percent minimum in accordance with AASHTO T 195), and allows the required compaction to be achieved.

TABLE 1.004.2 - HMA MIXTURE MIXING TEMPERATURE LIMITS

| 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 76-28 | 320 | 280 |
| PG 64-28 | 320 | 280 |
| PG 58-34 | 300 | 280 |
| All temperatures shall be determined using a calibrated thermometer. | | |
| Reference the supplier's recommendation for temperatures; varies from producer to producer and asphalt supplier; need to follow the viscosity charts provided by the asphalt supplier. | | |

¹The 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.

I. Preparation of the Underlying Surface. The HMA mixture shall be placed on a prepared surface. 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 contract or approved plans.

J. Tack Coat. This work consists of preparing and treating the surface that will be receiving the HMA mixture 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 and gutter, crosspans and manholes, or the underlying courses of multi-course asphaltic pavement structure, shall receive a tack coat as required to ensure bonding of the new mat.

The asphaltic material for all tack coats shall meet the requirements of Section 1.002.E.2. The emulsified asphalt shall be diluted to not more than 1:1 with water and applied at a minimum of 0.10 ± 0.02 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 thoroughly cleaned of all dirt and other debris to insure 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 in order 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 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 is not in excess of 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.

K. 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. The backfill and base coarse 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.

Existing pavement may be rough cut initially in conjunction with trenching; however, a square even vertical cut shall be made in the existing hot mix asphalt pavement after placement of backfill and prior to pavement replacement. The square vertical cut shall be made at a minimum of six (6) inches back from the trench line into good pavement. 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 a hot asphalt cement and aggregate mixture.

In large patches or whenever possible, a self-propelled paving machine shall be used to place the mixture. In small patches, the material shall be hand placed or placed with a spreader box without separation of the mixture. The material shall be placed to the grade and thickness required to allow for compaction after rolling. The hot mix material shall be compacted using the number, weight and type of rollers required to provide 92-96% of the maximum density of the mix (AASHTO T-209). Rolling shall continue until all roller marks are eliminated and no further compression is possible in the pavement. After rolling the surface, a straightedge or a stringline shall be used to check grade and riding quality of the patch.

L. Hauling of HMA Mixture. Transporting the HMA mixture from the plant to the job site shall be done in vehicles meeting the requirements of Section 1.004.E. The Contractor shall have an adequate number of vehicles so delivery of the HMA mixture can be continuous with a minimum of interruptions of material to the paving equipment in order for a continued non-stop paving operation and before the temperature of the HMA material falls below 235 degrees Fahrenheit for non-modified material or not less than 275 degrees Fahrenheit for polymerized modified material. 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 degrees Fahrenheit, all loads shall be delivered continuously in covered vehicles meeting the requirements in Section 1.004.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.

M. Placing of HMA Mixture. The HMA mixture shall be placed using equipment meeting the requirements in Section 1.004.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 HMA 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 Section 1.004.M.1.b. or the mat temperature falls enough that the compaction can not 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.

1. Segregation. The HMA mixture shall be transported and placed on the roadway without segregation. If at any time, the Engineer observes segregated areas of pavement, 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:

- a. 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.
- b. 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.
- c. Gradation of the aggregate of the cores will be determined in accordance with CP 46.
- d. The core aggregate gradations from the segregated area will be compared to the core aggregate gradations of the corresponding non-segregated area.

e. 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 1.004.3, the area is segregated.

TABLE 1.004.3 - SEGREGATION DETERMINATION

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

f. 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 that results in a non-segregated top lift. Segregated areas in lifts below the top lift, that are 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 corings 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 ten cores, not to exceed \$2,000 total.

2. Lift Thickness. Each lift of compacted asphalt pavement shall be of uniform thickness. The minimum uncompacted lift thickness shall be three times the nominal aggregate size of the mixture. The maximum lift thickness shall be 3 inches unless the Contractor can demonstrate his ability to achieve required compaction of thicker lifts.

The final lift, when placed adjacent to guttering, shall extend ¼ to ½ inch above the lip of the gutter when compacted for a catch curb and gutter and shall be even with a spill curb and gutter at the time of construction.

The average required compacted thickness shall be as specified on the construction drawings, with no core thickness less than 90 percent of the specified thickness.

3. 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.

a. 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 inches. In multiple lift (3 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 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:

- (1) For two lane roadways, offset 6 to 12 inches from the center of pavement and from the outside edge of the travel lanes.
- (2) For roadways of more than 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:

- (1) Leave a vertical exposed longitudinal joint when the thickness of the pavement course being placed is 1.5 inches or less.
- (2) Leave an exposed longitudinal joint when the thickness of the pavement course being placed is greater than 2 inches provided that the top 1 inches of the longitudinal joint shall be vertical. The remainder of the joint, below 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 HMA mixture against the edge.

b. 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 HMA mixture 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% of the thickness of the existing completed mat, so that adequate grade and compaction can be achieved on starting the paving operation.

4. Compaction. The hot mix asphalt 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 cement (PG 58-28 or PG 64-22) or modified (PG 58-34), and the surface temperature falls below 185 °F, further compaction effort shall not be applied unless approved. 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 approved.

All 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 rolling on bridge decks covered with waterproofing membrane.

Pavement shall be compacted to a density of 92 to 96 percent of the maximum theoretical density, determined according to CP 51. Field density determinations will be made in accordance with CP 44 or 81. Core samples and compaction testing locations shall include a representative sampling of tests taken at 12 inches for one lift paving and 18 inches for multiple lift paving from visible joint lines for both longitudinal and transverse joints, in order 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.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers.

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 with the surrounding area.

N. Testing and Inspection. Acceptance of the work will be based on the following characteristics of the bituminous mixture and completed pavement as well as the implementation of the Contractor's Quality Control (QC) plan and test results:

- Binder grade certification
- Binder Content
- Aggregate gradation
- Air Voids
- Voids in Mineral Aggregate (VMA)
- Mat density
- Mat smoothness

Quality Control testing of plant produced materials for material gradation and asphalt content shall be performed by the Contractor. All failing tests shall be immediately reported to the Engineer. Test results from each day's production shall be completed and submitted to the Engineer within one day.

Personnel performing sampling and testing of bituminous mixtures in the lab and field shall possess the appropriate LabCat Certification or combination of certifications for all sampling and testing performed issued by the Rocky Mountain Asphalt Education Center.

The owner reserves the right to conduct quality assurance (QA) testing. The owner will pay for passing QA tests. All failing tests and required retests and corrective actions will be paid by the contractor. The cure for failed testing is at the discretion of the owner/agency engineer, and may include remove/replace, deductive change order or extended warranty (w/bond).

1. Testing. Testing frequencies and tolerance limits shall be as shown in Table 1.004.4. For development projects this testing shall be performed by an independent testing lab, paid for and provided by the developer, and reported to the owning entity. For City/County contracts, testing responsibilities will be made a part of the contract provisions.

TABLE 1.004.4 - QC TESTING FREQUENCIES AND TOLERANCES¹

| Test | Procedure | Specification Tolerance Limits | Frequency |
|---------------------------|-----------------------------|--------------------------------|--|
| Asphalt Binder Content | AASHTO T 308-01 (CP-L 5120) | ± 0.4% | 1 per 1000 Tons ² or 1 per day min. |
| Gradation | AASHTO T 27-99 (CP 31A) | Table 1.004.6 | 1 per 1000 Tons ² or 1 per day min. |
| Air Voids | AASHTO T 269-97 | 2.8% to 5.2% | 1 per 1000 Tons ^{2,3} or 1 per day min. |
| Void in Mineral Aggregate | CP 48-95 | Table 1.003.3 | 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 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 Upon verification in accordance with Section 1.003, air voids and VMA testing frequency may be 1 per 10,000 tons or 1 per week minimum.

a. Plant-Produced Material. Sampling may be at the plant or at the job site. Sufficient material for preparation of test specimens shall be obtained by the Contractor in accordance with CP 41-98. When the owner chooses to conduct QA testing, and when a developer's testing lab is conducting QC testing, samples shall be split with the owner's materials laboratory. One set of laboratory compacted specimens will be prepared for each at the number of gyrations required in Table 1.003.1. Each set of laboratory compacted specimens will consist of three test portions prepared from the same sample increment. The sample of HMA mixture may be placed in an oven in a covered metal container for not more than 30 minutes to maintain heat. The material shall be compacted at the temperature as specified in the job mix formula.

Testing of plant produced material for Air Voids and VMA shall be determined in accordance with the procedures shown in Table 1.004.4. For air voids determination, the theoretical maximum specific gravity of the mixture shall be determined in accordance with CP51-98. The plant produced material for air voids and VMA shall be accepted if the materials are within the specification limits, as per Table 1.004.5.

TABLE 1.004.5 - ACCEPTANCE LIMITS FOR AIR VOIDS, VMA AND DENSITY

| Test | Lower Specification Tolerance Limit | Upper Specification Tolerance Limit |
|---|-------------------------------------|-------------------------------------|
| Air Voids total mixture ¹ | 2.8% | 5.2% |
| VMA | Table 1.003.3 | NA |
| In-Place Density (percent relative compaction) | 92 | 96 |

¹ Corrective action, including a re-verification of mix design as specified in Section 1.003, must be taken when test results are outside of these action limits. Suspend work at less than 2.5% or greater than 5.5%, and submit a new mix design.

The plant produced material shall be accepted for gradation if the gradation of the aggregate falls within the limits shown in Table 1.004.6. Two consecutive gradations falling outside the Action Limits or one gradation 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.

TABLE 1.004.6 - CONTROL LIMITS FOR INDIVIDUAL 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 % |

The plant produced material shall be accepted for binder content if the binder meets the specification in Table 1.002.5 for the binder grade specified.

b. Field Placed Material. Hot mix asphalt pavement shall be tested for in-place density in accordance with Table 1.004.7 (below). Densities shall be determined by core sampling in most cases and for all development projects.

TABLE 1.004.7 - DENSITY TESTING

| Test | Procedure | Specification Tolerance Limits | Frequency |
|-----------------------------|-----------|-----------------------------------|---|
| Percent Relative Compaction | CP 51-98 | 94% ± 2% | 1 per 500 linear feet per lane of paving |

On non-development projects (i.e. city or county projects), if nuclear density measurements are allowed by the engineer for acceptance of field placed material, they shall be taken in accordance with CP 81-01. The nuclear density gauge shall be calibrated to a minimum of six 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 taken into account when determining the basis for the density test correlation. Small quantities of HMA are not applicable to CP 81-01 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. Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. Cores shall not be taken closer than one foot from a transverse or longitudinal joint. 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 in a manner acceptable to the owner and within one day after sampling.

Test results of the percent of relative compaction (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 Job Mix Formula (JMF). Testing frequency for Percent Relative Compaction shall be in accordance with Table 1.004.7.

The required compacted HMA mat thickness shall be as specified on the construction plans and/or specified in the Special Conditions. Final mat thickness shall be determined from the same cores as are used to test for density. No core thickness shall be less than ninety percent (<90%) of the specified thickness on the construction plans and/or Special Conditions. When core thickness is less than ninety percent (<90%) of that specified 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.

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

- Mix Design
- Aggregate Grading
- Quality of Materials
- Stockpile Management
- Proportioning
- Mixing and Transportation
- Placing and Finishing
- Asphalt Binder
- Air Voids
- Voids in Mineral aggregate (VMA)
- Compaction
- Surface Smoothness

a. Testing Laboratory. The Contractor shall provide a fully equipped asphalt laboratory or shall hire an independent testing laboratory for quality control testing. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Owner's designated representative shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality 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.

b. Quality Control Testing. The Contractor shall develop a quality control testing plan and perform all quality control tests necessary to control the production and construction processes applicable to these specifications. Quality control test results shall be submitted to the Engineer within 24 hours of sampling. Personnel performing sampling and testing of aggregates or bituminous 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 QC testing are shown in Table 1.004.4.

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

(1) 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.

(2) Air Voids and VMA. Air Voids and VMA shall be tested in accordance with AASHTO T 269-97 and CP 48-95, respectively, at a minimum frequency of 1 test per 1,000 tons or 1 test per day. Upon verification in accordance with Section 1.003, Air Voids and VMA testing frequency may be reduced to 1 test per 10,000 tons or 1 test per week minimum.

(3) 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.

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

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

(6) Moisture Content of Mixture. The moisture content of the mixture shall be determined in accordance with AASHTO T 110 or CP42-90.

(7) 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.

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

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

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

(11) 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.

(12) 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.

O. Method of Measurement. The accepted quantities of hot mix asphalt pavement will be measured by the ton for the compacted thickness of pavement specified in each pay item. Batch mass (weights) will not be permitted as a method of measurement. The tonnage shall be the mass (weight) used in the accepted pavement.

Hot Mix Asphalt pavement courses measured by the square yard will be paid for at the contract unit price per square yard. This payment shall be full compensation for materials, tools, equipment and labor necessary to complete the work under this section in accordance with the plans and these specifications. The payment shall be full compensation for prime and/or tack coats applied in accordance with these specifications.

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

P. Basis of Payment. The accepted quantities of hot mix asphalt 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 for furnishing all materials, for preparation, mixing, placing and compaction of these materials and for all labor, equipment, tools 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.

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Appendix A

| HOT MIX ASPHALT PREPAVING CONFERENCE AGENDA | | | |
|---|--|-------------------|--|
| <i>The items in the following agenda are minimum requirements that should be covered during the conference. The agenda may be used as is or as a base to develop a customized agenda.</i> | | | |
| Project Number: | | Owner's Rep: | |
| Project Code (SA): | | Project Engineer: | |
| Location: | | Contractor: | |
| Date: | | Superintendent: | |
| Time: | | Foreman: | |
| I. Attendance Roster | | | |
| Name: | | Office Number: | |
| Representing: | | Fax Number: | |
| Responsibilities: | | Cell Number: | |
| City, State, Zip: | | Email Address: | |
| | | | |
| Name: | | Office Number: | |
| Representing: | | Fax Number: | |
| Street Address: | | Cell Number: | |
| City, State, Zip: | | Email Address: | |
| | | | |
| Name: | | Office Number: | |
| Representing: | | Fax Number: | |
| Street Address: | | Cell Number: | |
| City, State, Zip: | | Email Address: | |
| | | | |
| II. Project Organization and Status | | | |
| A. OWNER/AGENCY Personnel: | | | |
| 1. Personnel in Charge at Paving Site: | | | |
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |
| 2. Alternate Contact (when personnel identified in A.1 is not present): | | | |
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |
| 3. Quality Assurance Supervisor: | | | |
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |
| 4. Inspector/Duties: | | | |
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |
| 5. Inspector/Duties: | | | |
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |
| Comments | | | |

HOT MIX ASPHALT PREPAVING CONFERENCE AGENDA (continued)

B. CONTRACTOR / DEVELOPER Personnel:

1. Quality Control Supervisor:

| | | | |
|----------------|--|----------------|--|
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |

2. Personnel to Notify at Paving Site

| | | | |
|----------------|--|----------------|--|
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |

3. Other:

| | | | |
|----------------|--|----------------|--|
| Name/Title: | | Fax Number: | |
| Office Number: | | Home Number: | |
| Mobile Number: | | Email Address: | |

Comments

C. Testing Information: (Compaction Test Results, acceptance tests to be performed, frequency)

1. Test locations determined by?

2. Frequency of tests to be performed?

3. Are Quality Assurance tests to be performed in addition to Quality Control tests?

➤ If Yes how often, and who will be responsible to schedule the QA tests?

4. Turn around time of test results?

➤ Preliminary?

➤ Final?

5. Is the mix design(s) approved by the Owner/Agency?

D. Submittal and Notification of Test Results

1. What projects and affected owners/agencies will this JMF be provided to?

2. What process will be provided for submittal of test results?

3. Who should copies of the JMF be provided to?

4. Who will be responsible for QA testing?

III. Scheduling

A. Materials:

Materials will be available for sampling on:

B. Asphalt Plant:

The asphalt plant will be ready to be checked on:

C. Paving Equipment:

The paving equipment will be set up and ready to be checked on:

HOT MIX ASPHALT PREPAVING CONFERENCE AGENDA (continued)

D. Paving Sequence:

1. The Contractor will commence paving on:
2. Hot Bituminous Pavement will be delivered at:
3. The Contractor proposes to work the following hours:
4. How many days per week does the Contractor intend to work?
5. What paving sequence will the Contractor follow?
6. Where will paving start?

E. A quality control plan shall provide information to control the quality of the following:

1. Segregation:
2. Longitudinal Joint Construction:
3. Transverse Joint Construction:
4. Smoothness:
5. Other:

F. Scales and Certified Weigher:

1. Scales shall be checked and sealed. Comments:
2. Weigh tickets shall contain information required by the owner. Comments:
3. Are truck weigh ticket required to be delivered on site? How will the weight tickets be collected? Comments:

IV. Preparation

A. Method of Approval SubSurface Materials?

Comments:

B. Has the Subsurface Been Approved for Paving?

➤ Approved By Who?

C. Tack Coat:

1. Material type, Application Rate?

V. Production and Placement

A. Compaction Test Section:

The following procedures should be observed and documented:

1. The Contractor must establish a roller pattern and carefully record the following information:
 - a. Type, size, amplitude, frequency, and speed of roller:

HOT MIX ASPHALT PREPAVING CONFERENCE AGENDA (continued)

V. Production and Placement (continued)

b. Tire pressure for rubber tire rollers and if the pass for vibratory rollers is vibratory or static:

c. Surface temperature of mixture behind the laydown machine and subsequent temperatures and densities after each roller pass:

d. Sequence and distance from laydown machine for each roller and total number of passes of each roller to obtain specified density:

2. When the Compaction Test Section has been completed, the Contractor shall furnish a complete copy of this data to the person in charge (II.A.1) before continuing to pave. Comments:

3. When a successful Compaction Test Section has been completed, the Contractor is required to maintain the roller pattern established during the Compaction Test Section for the balance of the Hot Bituminous Pavement construction (i.e., the Contractor must use the same number and type of rollers and operate them at the same speed, frequency, and amplitude and in the same position, relative to the laydown machine, as was performed during the Compaction Test Section). If the Contractor wants to change the roller pattern that was established during the Compaction Test Section, the Contractor must construct a new Compaction Test Section and demonstrate that the density can be obtained with the new roller pattern before proceeding with the paving operation.
Comments:

4. The Contractor is responsible for compaction testing of the Compaction Test Section. Comments:

HOT MIX ASPHALT PREPAVING CONFERENCE AGENDA (continued)

V. Production and Placement (continued)

5. Cores are required to calibrate the nuclear density gauge. The Contractor can continue to pave under the following conditions:
 - The period that the Contractor continues to pave without test results from cores shall not exceed one working day.
 - Construction proceeds at the Contractor's risk.
 Comments:

6. A new Compaction Test Section will be required whenever there is a change in the compaction process. Comments:

7. Striping plan: Sub Contractor or contractor to do striping?
 When will striping occur?
 When will striping occur?
 Have Materials Data Sheets been submitted? Approved? If Not when?

B. Laydown Equipment:

1. Does the paving equipment meet the requirement detailed in the specifications? Comments:

VI. Traffic Control

A. Method of Handling Traffic:

Has the Method of Handling Traffic been submitted for the Mix Asphalt Pavement placement operation?
 If not, when will it be submitted?
 Is the traffic control plan approved?

VII. Follow Up Items

Items discussed during the meeting, which will need follow up.

| Item for follow up | Who will follow up | Date of completion or response |
|---------------------------|---------------------------|---------------------------------------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

Appendix B

Mixture Design Requirements for Hot Mix Asphalt Pavements (HMAP)

Agency: _____ Project Number: _____

Date: _____ Project Name: _____

Project Special Provision Sheet for Hot Mix Asphalt Pavements (HMAP)

This form is a **mandatory part of the bid documents**, and shall be filled out by the AGENCY for each mix specified. The Contractor shall include a copy of this form with each Mix Design submittal after the contract is awarded.

Street Classification: _____

(examples: Residential, Collector, Arterial, Industrial, Parking Lot)

Construction Application: Top Lift Intermediate Lift(s) Bottom Lift(s)
 Patching Other _____

Aggregate Gradation: Grading SX Grading S Other _____
< 2" thick lifts 2" to 3" thick lifts

RAP Quantity, Maximum: 0% 20% Other _____

Mix Design Method & Compaction Level: (Chose one Method & one Traffic Level ⇒ Compaction Level)

Superpave Gyration, N_{design} : (See Table 1.003.1)

N=75 N=100

Asphalt Binder:

PG 58-28 PG 64-22 PG 64-28 Other _____

A completed Asphalt Mix Design Form shall supplement the Construction Specifications defining the contract specific requirements. Refer to the Specifications for details.
