# Balanced Mix Design Requirements for Sec 403 Asphaltic Concrete Pavement JSP-24-01

**1.0 Description.** Balanced Mix Design (BMD) and Paver-Mounted Thermal Profiles (PMTP), as specified herein, are required on this project for all Sec 403 asphaltic concrete pavement surface and base course mixes. BMD shall be in accordance with section 2.0. PMTP shall be in accordance with section 3.0. No additional payment will be made for compliance with these provisions.

**1.1 Rapid Penetrating Emulsion.** Should use of Rapid Penetrating Emulsion (RPE) be necessary for corrective action of longitudinal joint density, as specified elsewhere in section 2.0, RPE shall be in accordance with MoDOT JSP2303 Rapid Penetrating Emulsion (available at: <https://epg.modot.org/index.php/Job_Special_Provisions>), except that no payment will be made for use of RPE.

**2.0** *Delete Sec 403 in its entirety and substitute the following:*

**403 ASPHALTIC CONCRETE PAVEMENT with Balanced Mix Design**

1. **Description.** This work shall consist of providing a bituminous mixture to be placed in one or more courses on a prepared base or underlying course as shown on the plans or as directed by the engineer. The contractor shall be responsible for QC of the bituminous mixture, including the design, and control of the quality of the material incorporated into the project. The engineer will be responsible for QA, including testing, to assure the quality of the material incorporated into the project.
	1. **Naming Convention.** The nomenclature of Superpave bituminous mixture names, such as SP125CLP, will be as follows. When only the aggregate size is shown, such as SP125, the specifications shall apply to all variations of that size, such as SP125B, SP125C, SP125CLP, etc. When "x" is indicated, such as SP125xLP, specifications shall apply to all variations of mixture designs. Stone Matrix Asphalt will be generally referred to as SMA and designated by SM or SMR.

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| **Superpave Nomenclature** |
| **SP** | **Superpave** |
| 048 | 4.75mm (No. 4) nominal aggregate size |
| 095 | 9.5 mm (3/8 inch) nominal aggregate size |
| 125 | 12.5 mm (1/2 inch) nominal aggregate size |
| 190 | 19.0 mm (3/4 inch) nominal aggregate size |
| 250 | 25.0 mm (1 inch) nominal aggregate size |
| x | Mixture design: B, C, E or F (as described below) |
| LP | Limestone porphyry (when designated) |
| SM | Stone Matrix Asphalt (when designated) |
| SMR | Stone Matrix Asphalt limestone/non-carbonate (when designated) |

* 1. **Design Levels.** The following cumulative equivalent single axle loads (ESALs) shall be used for the specified mix design. The same size aggregate mix design at a higher design traffic may be substituted at the contractor’s expense for the contract specified mixture design with the approval from the engineer. Substitutions shall be done uniformly and project mixing of various designs for the same work will not be permitted. For example, an SP125B mixture may be substituted for an SP125C mixture, or SP190C for SP190E, etc. Mixture design substitution will be limited to one design level higher than that specified in the contract.

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| **Design Traffic (ESALs)** | **Design** |
| < 300,000 | F |
| 300,000 to < 3,000,000 | E |
| 3,000,000 to < 30,000,000 | C |
| ≥ 30,000,000 | B |

1. **Material.** All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

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| **Item** | **Section** |
| Aggregate | 1002 |
| Asphalt Binder, Performance Graded (PG)\* | 1015 |
| Fiber Additive | 1071 |
| Anti-Strip Additive | 1071 |

\*The grade of asphalt binder will be specified in the contract.

* 1. **Stone Matrix Asphalt.** In addition to other requirements, material for SMA mixtures shall meet the following. Coarse aggregate shall consist of crushed limestone and either porphyry or steel slag in accordance with the quality requirements of Sec 1002, except as follows. The Los Angeles (LA) abrasion, when tested in accordance with AASHTO T 96, shall not exceed 40 percent based on initial ledge approval and source approval. The percent absorption, when tested in accordance with AASHTO T 85, shall not exceed 3.5 percent based on the individual fractions. The amount of flat and elongated particles, measured on material retained on a No. 4 sieve, of the blended aggregate shall not exceed 20 percent based on a 3:1 ratio or 5 percent based on a 5:1 ratio.
	2. **Filler Restriction.**  Rigden void content determined in accordance with MoDOT Test Method TM-73 shall be no greater than 50 percent.
	3. **Fibers.** A fiber additive shall be used as a stabilizer in SMA Mixtures. Fibers shall be uniformly distributed by the end of the plant mixing process. The dosage rate for fibers shall be no less than 0.3 percent by weight of the total mixture for cellulose and no less than 0.4 percent by weight for mineral fibers.
	4. **Reclaimed Asphalt.** A maximum of 30 percent virgin effective binder replacement may be used in mixtures without changing the grade of binder. The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. A correction factor for use during production may be determined for binder ignition by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction. The aggregate specific gravity shall be determined by performing AASHTO T 209 in accordance with Sec 403.19.3.1.2 and calculating the Gse to which a 0.98 correction factor will be applied to obtain the Gsb as follows:

RAP Gsb = RAP Gse X 0.98

* 1. **Reclaimed Asphalt Pavement.** Reclaimed Asphalt Pavement (RAP) may be used in any mixture, except SMA mixtures. Mixtures may be used with more than 30 percent virgin effective binder replacement provided testing according to AASHTO M 323 is included with the job mix formula that ensures the combined binder meets the grade specified in the contract. All RAP material, except as noted below, shall be tested in accordance with AASHTO T 327, *Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus.*  Aggregate shall have the asphalt coating removed either by extraction or binder ignition during production. The material shall be tested in the Micro-Deval apparatus at a frequency of once per 1500 tons. The percent loss shall not exceed the Micro-Deval loss of the combined virgin material by more than five percent. Micro-Deval testing will be waived for RAP material obtained from MoDOT roadways. All RAP material shall be in accordance with Sec 1002 for deleterious and other foreign material.
	2. **Reclaimed Asphalt Shingles.** Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22 in accordance with AASHTO PP 53 except as follows: When the ratio of virgin effective binder to total binder in the mixture is between 60 and 70 percent, the grade of the virgin binder shall be PG 52-28 or PG 58-28. Shingles shall be ground to 3/8-inch minus. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post-consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post-consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The gradation of the aggregate may be determined by solvent extraction of the binder or using the following as a standard gradation:

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| **Shingle Aggregate Gradation** |
| **Sieve Size** | **Percent Passing by Weight** |
| 3/8 in.  | 100 |
| No. 4  | 95 |
| No. 8  | 85 |
| No. 16  | 70 |
| No. 30  | 50 |
| No. 50  | 45 |
| No. 100  | 35 |
| No. 200  | 25 |

1. **Composition of Mixtures.**
	1. **Gradation.** Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract. A job mix formula may be approved which permits the combined aggregate gradation during mixture production to be outside the limits of the master range when the full tolerances specified in Sec 403.5 are applied.

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| **Percent Passing by Weight** |
| **Sieve Size** | **SP250** | **SP190** | **SP125** | **SP095** | **SP048** | **SP125xSM(R)** | **SP095xSM(R)** |
| 1 1/2 in.  | 100 | --- | --- | --- | --- | --- | --- |
| 1 in.  | 90 - 100 | 100 | --- | --- | --- | --- | --- |
| 3/4 in.  | 90 max. | 90 - 100 | 100 | --- | ---- | 100 | --- |
| 1/2 in. | --- | 90 max. | 90 - 100 | 100 | --- | 90-100 | 100 |
| 3/8 in.  | --- | --- | 90 max. | 90-100 | 100 | 50-80 | 70-95 |
| No. 4  | --- | --- | --- | 90 max. | 90-100 | 20 - 35 | 30-50 |
| No. 8  | 19 - 45 | 23 - 49 | 28 - 58 | 32-67 | --- | 16 - 24 | 20-30 |
| No. 16  | --- | --- | --- | --- | 30-60 | --- | 21 max. |
| No. 30  | --- | --- | --- | --- | --- | --- | 18 max. |
| No. 50  | --- | --- | --- | --- | --- | --- | 15 max. |
| No. 100  | --- | --- | --- | --- | --- | --- | --- |
| No. 200  | 1 - 7 | 2 - 8 | 2 - 10 | 2-10 | 7-12 | 8.0-11.0 | 8.0-12.0 |

* 1. **Anti-Strip Agent.** An anti-strip will be allowed by the engineer to improve resistance to stripping. Anti-strip agents and application rates shall be from a list approved in accordance with Sec 1071.
	2. **Porphyry Mixtures.** For LP and SMA mixtures, at least 50 percent by volume of the aggregate shall be crushed porphyry retained on the following sieves: No. 30 for SP048, No. 16 for SP095 and No. 8 for SP125. Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required may vary, however at least 40 percent by weight of crushed porphyry will be required. Steel slag may be substituted for porphyry in LP and SM mixtures, except at least 45 percent by weight of crushed porphyry and/or slag will be required. The engineer may approve the use of other hard, durable aggregate in addition to porphyry and steel slag. When an SMR mixture is designated, the mixture shall contain aggregate blends with at least 30 percent non-carbonate material in accordance with Sec 403.3.5.
	3. **Minimum Stone Matrix Asphalt Binder.** The percent asphalt binder for SMA mixtures shall not be less than 6.0 percent unless otherwise allowed by the engineer.
	4. **Surface Mixtures.**  Design level B surface mixtures and SP048NC, except as described in Sec 403.15.3, containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate. The LA abrasion values, AASHTO T 96, of the limestone will determine the type and amount of non-carbonate aggregate required as shown in the table below. The LA abrasion value will be determined from the most recent source approval sample. In lieu of the above requirements, the aggregate blend shall have an acid insoluble residue (AIR), MoDOT Test Method TM 76, meeting the plus No. 4 criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an AIR of at least 85 percent insoluble residue.

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| **Coarse Aggregate (+ No. 4)** | **Minimum Non-Carbonate by Volume** |
| Limestone, LA ≤ 30 | 30% Plus No. 4 |
| Limestone, LA > 30 | 20% Minus No. 4\* |
| Dolomite | No Requirement |

\*Use for all SP095 and SP048NC containing limestone.

1. **Job Mix Formula.** At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design for approval to Construction and Materials. The mixture shall be designed in accordance with AASHTO R 35 or R 46 and shall be tested in accordance with AASHTO T 312 except as noted herein. A detailed description of the mix design process shall be included with the job mix formula (JMF). Representative samples of each ingredient for the mixture shall be submitted with the mix design.
	1. **Proficiency Sample Program.** Laboratories that participate in and achieve a score of three or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304 (ASTM C 1252), T 308 and T 312 will have the mixture verification process waived. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production.
	2. **Required Information.** The mix design shall include raw data from the design process and contain the following information:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number if applicable, gradation, and deleterious content of each aggregate fraction.

(c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate including all raw data.

(d) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(e) Percentage of each aggregate component.

(f) Combined gradation of the job mix.

(g) Percent asphalt binder, by weight, based on the total mixture and percent asphalt binder contributed by reclaimed asphalt materials.

(h) Bulk specific gravity (Gmb) by AASHTO T 166 Method A of a laboratory compacted mixture compacted at Ndesign gyrations.

(i) Percent air voids (Va) of the laboratory compacted specimen compacted to Ndesign gyrations.

(j) Voids in the mineral aggregate (VMA) and volume of Effective Asphalt (Vbe) at Ndesign gyrations.

(k) Theoretical maximum specific gravity (Gmm) as determined by AASHTO T 209, in accordance with Sec 403.19.3, after the sample has been short term aged in accordance with AASHTO R 30.

(l) The tensile strength ratio as determined by AASHTO T 283 including all raw data.

(m) The gyratory sample weight to produce a 115 mm minimum height specimen.

(n) Mixing temperature and gyratory molding temperature.

(o) Number of gyrations at Ndesign.

(p) Dust proportion ratio (-200/Pbe).

(q) Bulk specific gravity (Gsb) of the combined aggregate.

(r) Percent chert contained in each aggregate fraction.

(s) Percent of Gmm at Ninitial and Nmaximum.

(t) Voids in coarse aggregate (VCA) for both the mixture and dry-rodded condition for SMA mixtures.

(u) Draindown for SMA mixtures.

(v) Performance testing results for Cracking Tolerance Index (CTIndex), Critically aged Cracking Tolerance Index (CTIndex,CriticallyAged), Hamburg Wheel Tracking Test (HWTT), and Rutting Tolerance Index (RTIndex).

(w) Baghouse fines added for design.

(*i*) Batch and continuous mix plants – Indicate which aggregate fraction to add baghouse percentage during production.

(*ii*) Drum mix plants – Provide cold feed settings with and without baghouse percentage.

* 1. **Approval.** No mixture will be accepted for use until the JMF for the project is approved by Construction and Materials.
	2. **Mix Formula Modification.** The JMF approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results occur or should a source of material be changed, a new JMF may be required.
		1. **Asphalt Binder Source Change.** When an asphalt binder source change includes a binder grading that differs from the original grade on the JMF, new performance testing values (CTIndex and RTIndex) shall be provided prior to use.
		2. **Additive Source Change.** When rejuvenators, warm mix additives, anti-strip additive, or other additives sources change; new performance testing values (CTIndex and RTIndex) shall be provided.
	3. **Design Gyrations.** The minimum number (N) of gyrations required for gyratory compaction shall be as follows:

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| **Design** | **Ndesigna** |
| F | 35 |
| E | 50 |
| C | 60 |
| B | 65  |

a SMA mixtures shall have Ndesign equal to 100.

* 1. **Mixture Characteristics.** When compacted in accordance with AASHTO T 312, the mixture shall meet the following criteria.
		1. **Air Voids (Va).** Design air voids for SuperPave mixtures at all traffic levels shall be between 3.0 and 5.0 percent. SMA mixtures shall have a design air void of 4.0 percent.
		2. **Voids in the Mineral Aggregate (VMA)**. SuperPave mixtures shall have a minimum volume of effective asphalt, equal to the VMA minus the air voids, as shown in the chart below, with design air voids between 3.0% to 5.0% for SupePave and shall be 4.0% for SMA. The minimum VMA shall be equal to the minimum volume of effective binder (Vbe) plus design air voids.

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| **Mixture** | **Vbe Minimum (percent)** |
| SP250 | 9.0 |
| SP190 | 10.0 |
| SP125 (except for SMA) | 11.0 |
| SP095 (except for SMA) | 12.0 |
| SP048 | 13.0 |
| SMA | 13.0 |

* 1. **Dust to Binder Ratio.** For all mixtures except SMA and SP048, the ratio of minus No. 200 material to effective asphalt binder (Pbe) shall be between 0.8 and 1.6. For SP048, the ratio of minus No. 200 material to effective asphalt binder (Pbe) shall be between 0.9 and 2.0.
	2. **Moisture Susceptibility.** For all mixtures except SMA, the mixture shall have a tensile strength ratio (TSR) greater than 85 percent (80 percent if an approved anti-strip agent is used) when compacted to 3.7 inches with 7 ± 0.5 percent air voids and tested in accordance with AASHTO T 283. SMA mixtures shall have a TSR greater than 85 (80 percent if an approved anti-strip agent is used) percent when compacted to 3.7 inches with 6 ± 0.5 percent air voids and tested in accordance with AASHTO T 283.
		1. **Minimum Tensile Strength.** All mixtures shall have a minimum allowable conditioned tensile strength of 60 psi.
		2. **Liquid Anti-Stip Dosage.** The liquid anti-strip dosage shall be in the range recommended by the manufacturer and provided on the JMF.
	3. **Draindown.** AASHTO T 305, Draindown Test, shall be performed on all SMA mixtures prior to job mix approval. The mixture shall be stabilized in such a way that the draindown of the asphalt binder shall not exceed 0.3 percent by weight of mixture.
	4. **Voids in Coarse Aggregate.** The percent VCAMIX of SMA mixtures shall be less than or equal to the VCADRC as determined using AASHTO T 19. This may be calculated using the following equations:

 VCADRC = 100 x (GCAγw - γs) / GCAγw

 VCAMIX = 100 - (Pbp x Gmb / GCA)

 Pbp = Ps x PAbp

Where: GCA = bulk specific gravity of the combined coarse aggregate

 (AASHTO T 85),

γs = unit weight of coarse aggregate in the dry-rodded condition (DRC) (lb/ft3) (AASHTO T 19),

γw = unit weight of water (62.34 lb/ft3) ,

Pbp = percent aggregate by total mixture weight retained on No. 4 sieve and

PAbp = percent aggregate by total aggregate weight retained on No. 4 sieve\*.

 \*Use No. 8 sieve for SP095xSM

* 1. **Mix Design Performance Testing.**  Acceptable test results meeting the criteria for the following performance tests shall be submitted with the mix design for approval. Test specimens shall be compacted to an air void content of 7.0 +/- 0.5% or 6.0 ± 0.5% for SMA mixtures.
		1. **Cracking Tolerance Index (CTIndex) Testing.** The CTIndex testing shall be completed in accordance with ASTM D8225 and at a test temperature of 25 +/- 0.5 °C.

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| **Mix Type** | **Minimum CTIndex** | **CTIndex,(Critically Aged)\*** |
| Non-SMA | 50 | Informational Only  |
| SMA | 135 | Informational Only |

\*Critically Aged defined as loose mix aging for 20 hours at 115° C.

* + 1. **Rutting Tolerance Index (RTIndex) Testing.** The RTIndex testing shall be completed in accordance with ASTM D8360 and at a test temperature of 50 +/- 1°C.

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| **PG Grade High Temperature\*** | **Minimum RTIndex** |
| 58-28H / 64-22 | 50 |
| 64-22H / 70-22 | 65 |
| 64-22V / 76-22 | 80 |

\*Determined by the binder grade specified in the contract.

* + 1. **Hamburg Wheel Track (HWT).** HWT testing will be completed in accordance with AASHTO T324 at test temperature of 50 +/- 1°C and 2.44 in specimen height.

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| **PG Grade High Temperature \*** | **Minimum Wheel Passes** | **Maximum Rut Depth (in.)** |
| 58-28H / 64-22 | 7,500 | 0.38 |
| 64-22H / 70-22 | 15,000 | 0.38 |
| 64-22V / 76-22 | 20,000 | 0.38 |

\*Determined by the binder grade specified in the contract.

1. **Mixture Production Specification Limits.**
	1. **Gradation and Deleterious Content Control.** The gradation of the aggregate shall be determined from samples taken from the hot bins on batch-type or continuous mixing plants or from the composite cold feed belt on drum mix plants. The gradation may also be obtained by sampling the mixture and testing the residual aggregate. The deleterious content of the aggregate shall be determined from samples taken from the composite cold feed belt. The RAP shall be sampled from the RAP feeding system on the asphalt plant. Gradation and deleterious shall be taken when directed by the engineer.
		1. **Stone Matrix Asphalt Tolerances.** In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job mix formula are made. The maximum deviation from the approved job mix formula shall be as follows for SMA mixtures:

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| **Sieve** | **Max. Tolerance**  |
|  | SP095 | SP125 |
| 3/4 in.  | --- | --- |
| 1/2 in.  | --- | ±4 |
| 3/8 in.  | ±4 | ±4 |
| No. 4  | ±3 | ±3 |
| No. 8  | ±3 | ±3 |
| No. 200  | ±2 | ±2 |

* + 1. **Mixture Tolerance.** For all other SP mixtures, the percent passing the first sieve size smaller than the nominal maximum size shall not exceed 92.0 percent, a tolerance not to exceed 2.0 percent on the No. 8 sieve from the table in Sec 403.3.1, and within the range listed in Sec 403.3.1 for the No. 200 sieve The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.
	1. **Density.** The final, in-place density of the mixture shall be 92.5 to 98.0 percent of the theoretical maximum specific gravity for all mixtures except SMA. SMA mixtures shall have a minimum density of 94.0 percent of the theoretical maximum specific gravity. The theoretical maximum specific gravity shall be determined from a sample representing the material being tested. Tests shall be taken not later than the day following placement of the mixture. The engineer will randomly determine test locations.
		1. **Shoulder Density.**  Density on non-integral shoulders shall be in accordance with Sec 403.15.3.
		2. **Integral Shoulder.** When shoulders are placed integrally with the traveled way, tests shall be taken on the traveled way.
		3. **Longitudinal Joint Density.**  Density along longitudinal joints shall be in accordance with Sec 403.16.1. Pay shall be in accordance with Sec 403.23.4.1.
	2. **Asphalt Content.** The asphalt content (AC) shall be within ± 0.3 percent of the approved mix design.
	3. **Air Voids.** Air voids shall be within ± 1.0 percent of the approved mix design at Ndes gyrations.
	4. **Cracking Tolerance Index**. Minimum CTIndex shall be 50 for all mixtures except SMA. SMA mixtures shall have a minimum CTIndex of 135.
	5. **Rutting Tolerance Index.** Minimum RTIndex shall be based upon the high temperature asphalt binder grade in the contract in accordance with the following:

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| **PG Grade High Temperature\*** | **Minimum RTIndex(a)** |
| 58-28H / 64-22 | 50 |
| 64-22H / 70-22 | 65 |
| 64-22V / 76-22 | 80 |

\*Determined by the binder grade specified in the contract.

(a)Mixtures not meeting the minimum RTIndex shall be tested by the Hamburg Wheel Track Test and meet a minimum of ½” rutting at the number of wheel passes required by the contract grade of the mixture.

* 1. **Tensile Strength Ratio (TSR).** The TSR shall be greater than or equal to 75 percent as determined from loose mixture taken from the plant and tested in accordance with AASHTO T 283. The minimum allowable conditioned tensile strength of the mixture shall be 60 psi. The liquid anti-strip dosage during production shall match the dosage listed on the JMF.
	2. **Fibers.** The fiber proportioning and delivery system for SMA mixtures shall have an accuracy of 10 percent by weight of the material actually being measured in any given period of time.
	3. **Moisture Content.** The asphaltic concrete mixture, when sampled and tested in accordance with AASHTO T 329, shall not contain more than 0.5 percent moisture by weight of the mixture.
	4. **Contamination.** The asphaltic concrete mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent to the job mix formula.
1. **Field Laboratory.** The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. The gyratory compactor shall be evaluated in accordance with AASHTO PP 35. An approved list will be maintained by Construction and Materials. All other equipment shall be capable of performing tests in accordance with the approved test methods.
2. **Bituminous Mixing Plants.** Bituminous mixing plants and preparation of material and mixtures shall be in accordance with Sec 404.
3. **Hauling Equipment.** Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.
4. **Pavers.** Bituminous pavers shall be self-contained units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing asphaltic concrete in lane widths applicable to the specified typical sections and thicknesses shown on the plans.
5. **Construction Requirements.**
	1. **Weather Limitations.** No mixture shall be placed on any wet or frozen surface. No mixture shall be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 40 F. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.
	2. **Substitutions.** With approval from the engineer, the contractor may substitute a smaller nominal maximum size mixture for a larger sized mixture. Specifications governing the substitute mixture shall apply. Except for a single surface layer, the total pavement thickness shall be maintained when the substitute mixture layer is reduced as allowed in Sec 403.13 by increasing the thickness of other layers or courses. The contract unit price for the original mixture shall be used.
6. **Field Adjustments of Job Mix Formulas.** When test results indicate the mixture produced does not meet the specification requirements, the contractor may field adjust the job mix formula as noted herein. Field adjustments may consist of changing the percent binder as listed on the original approved job mix by no more than 0.3 percent. Additional fractions of material or new material will not be permitted as field adjustments. The engineer shall be notified immediately when any change is made in the cold feed settings, the hot bin settings or the binder content. A new Gsb shall be calculated using the new aggregate percentages. The gradation of the adjusted mixture shall meet the requirements of the mixture type specified in the contract. When the binder content is adjusted more than 0.3 percent, the mixture will be considered out of specification, and a new mix design shall be established.
	1. **Field Mix Redesign.** When a new mix design will be required, the contractor will be permitted to establish the new mix design in the field. The mixture shall be designed in accordance with AASHTO R 35 or AASHTO R 46 and shall meet the mix design requirements, including performance testing and TSR requirements. A representative sample of the mixture shall be submitted with the new mix design to the Central Laboratory for mixture verification. The amount of mixture submitted for verification shall weigh at least 50 pounds.
		1. **Approval.** New mix designs established in the field shall be submitted for approval to Construction and Materials. Upon approval, Construction and Materials will assign a new mix number to the mixture.
		2. **Resume Production.** No mixture shall be placed on the project until the new field mix design is approved.
7. **Application of Prime or Tack.** The prime coat, if specified, shall be applied in accordance with Sec 408. A tack coat is required on all existing pavement and shoulder surfaces that will be overlaid with a bituminous mixture. A tack coat is also required between all lifts of bituminous pavements placed within the driving and turn lanes, unless otherwise specified in the contract. All construction requirements of a tacked surface shall be in accordance with Sec 407, and specified herein. The tack coat shall be applied uniformly and shall completely cover the surface upon which the bituminous mixture is to be placed. Placement of a bituminous mixture shall not be placed upon a tacked surface that is not uniformly covered or surfaces that have experienced excessive loss of tack due to tracking. Re-application of tack due to excess tracking or non-uniform coverage shall be at the contractor’s expense.
8. **Spreading and Finishing.** The base course, primed or tacked surface, or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the asphaltic mixture. If lumps are present or a crust of mixture has formed, the entire load will be rejected. The thickness and width of each course shall conform to the typical section in the contract. The contractor may elect to construct each course in multiple layers. The minimum compacted thickness shall be 0.75 inches for SP048, 1.25 inches for SP095, 1.75 inches for SP125, 2 inches for SP190, and 3 inches for SP250.
	1. **Paving Widths.** The following shall apply for roadways constructed under traffic. For pavements having a width of 16 to 24 feet, inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement, and the full width shall be completed as soon as practical. Unless otherwise permitted, a single lane of any course shall not be constructed to a length that cannot be completed to full width of the pavement the succeeding operating day. For pavements greater than 24 feet wide, single lane width construction shall be limited to one day's production and completion to full width shall be accomplished as soon as practical. Uneven pavement shall be left in place for no more than seven days, unless approved by the engineer. Removal of pavement to be in accordance with this specification shall be at the contractor’s expense.
	2. **Segregation.** No thermal or physical mix segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed.

Paver Mounted Thermal Profiling (PMTP) shall be conducted in accordance with Sec 406.

All layers shall be feathered out, by hand raking, if necessary, in transitioning the depth of the surface to meet present grades at bridges or ends of projects, to provide a uniform, smooth riding surface free of irregularities. Where only the top layer of the surfacing continues across a bridge, the bottom layers shall be feathered out.

Any visual/physical segregation shall be tested in accordance with MoDOT Test Method TM 75. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.

* 1. **Release to Traffic.** If the asphaltic concrete construction consists of more than a single layer, each layer shall be compacted as specified and allowed to cool to the ambient temperature before the next layer is placed. The contractor shall keep traffic off the asphaltic concrete until the surface of the asphaltic concrete is 140 F or below and the asphaltic concrete has cooled sufficiently to prevent flushing of the asphalt binder to the surface, marking or distorting the surface or breaking down the edges.
	2. **Draindown.** Evidence of asphalt binder separation or draindown at delivery will be cause for rejection.
	3. **Shoulder Substitution.** When a Sec 403 mixture is specified for traffic lanes, the same mixture may be used for the adjacent shoulder, subject to the density requirements in Sec 403.5.2.
1. **Spot Wedging and Leveling Course.** The engineer will specify the locations and thickness of spot wedging and the thickness of leveling course to obtain the smoothest possible riding surface. This procedure may result in spot wedging operations over small areas with feather-edging at high points and ends of wedge areas. Rigid control of the placement thickness of the leveling course shall be required. Leveling course, consisting of a layer of asphaltic concrete of variable thickness used to superelevate curves and eliminate irregularities in the existing base, shall be spread uniformly to the specified profile grade and cross section. The mixture shall be uniformly spread and compacted, with only minor segregation as accepted by the engineer. Type SP125 or finer mixtures, as applicable, shall be used for the spot wedging and for the leveling course. Mixtures used as spot wedging and leveling courses shall be accepted in accordance with Sec 403.23.8.3.
2. **Compaction.** After the asphaltic mixture has been spread, struck off and surface irregularities adjusted, the asphaltic mixture shall be compacted thoroughly and uniformly by rolling to obtain the required compaction while the mixture is in a workable condition. Excessive rolling, to the extent of aggregate degradation, will not be permitted. Rollers shall not be used in the vibratory mode when the mixture temperature is below 225 F. When warm mix technology is used, as approved by the engineer, rollers shall not be used in the vibratory mode when the mixture temperature is below 200 F .
	1. **Rolling.** Any displacement occurring as a result of starting, stopping or changing direction of a roller, or from other causes, shall be avoided. Excess liquid, to prevent adhesion of the mixture to the rollers, will not be permitted. Diesel fuel, fuel oil or other detrimental products shall not be used as wetting agents. Along forms, curbs, headers, walls, and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers.
	2. **Defective Mixture.** Any mixture that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt binder shall be removed and replaced.
	3. **Non-Traffic Areas.** Sec 403 mixtures used for surfacing medians and similar areas, shoulders adjacent to rigid or flexible pavement and shoulders adjacent to resurfaced pavement shall be compacted to the specified densities for the mixture. Once an established rolling pattern has been demonstrated to provide the required density for shoulders, at the engineer's discretion, the pattern may be used in lieu of density tests provided no changes in the material, typical location or temperatures are made. Regardless of the method, density will still be required and subject to testing as deemed necessary by the engineer. In lieu of roller and density requirements, temporary bypasses to be maintained at the expense of the contractor shall be thoroughly compacted. The rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation.
	4. **Density Measurement.** Measurements for determining the in-place density of the mixture shall be taken no later than the day following placement. Measurements not obtained within the prescribed time limits shall be subject to the requirements of Sec 403.22.
		1. **Density Cores.** If a core is taken, material from underlying layers that remain adhered to the core shall be removed in a manner that does not harm the integrity of the specimen. If the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.
		2. **Nuclear/Alternative Methods.** In-place asphalt density may be obtained by nuclear or alternative methods in accordance with MoDOT TM-41. The nuclear/alternative calibration locations shall be conducted within a trial section in accordance with Sec 405.4.8.
	5. **Intelligent Compaction.** Intelligent Compaction requirements in accordance with Section 405 shall not apply unless required by job special provision. Intelligent compaction shall be conducted on the traveled way to monitor the optimum roller passes at a mean temperature above 180 F in accordance with Sec 405. Passing Segments shall have a minimum of 85% coverage at or above the optimum number of passes. Segments with between 85% and 70% coverage will be called moderate segments. Any segment with less than 70% coverage at the optimum number of passes shall be a Deficient Segment. If 70% of the target IC-MV is not obtained, the segment shall be flagged accordingly in the Veta project file. All segments with a mean temperature of less than 180 F at the optimum pass shall be considered deficient.
	6. **Surface Smoothness.** The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement surface shall be thoroughly tested for smoothness by profiling or straight edging in accordance with Sec 610.
3. **Joints.** Transverse joints shall be formed by any method that will produce a dense, vertical section for use when laying is resumed. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the engineer. The joint formed when the fresh mixture is placed shall be dense, well sealed, and the grade, line and surface texture of the succeeding surface shall conform to that of the joined surface. If directed by the engineer, the transverse joint shall be painted with a light coating of liquid asphalt. Hand manipulation of the mixture shall be minimized to avoid unsightly surface texture.
	1. **Joint Composition.** Longitudinal joints shall be formed by the use of an edging plate fixed on both sides of the finishing machine. Care shall be taken to obtain a well bonded and sealed longitudinal joint by placing the hot mixture in a manner ensuring maximum compaction at this point. If directed by the engineer for properly sealing the longitudinal joint, a light coating of bituminous material shall be applied to the exposed edge before the joint is made. Each side of the joint shall be flush and along true lines.
	2. **Joint Offset.** The longitudinal joint in any layer shall offset that in the layer immediately below by a minimum of 6 inches; except, the joints in the completed surfacing shall be at the lane lines of the traveled way or other required placement width outside the travel lane. The placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint.
4. **Quality Control.**
	1. **Quality Control Operations.** The contractor shall maintain equipment and qualified personnel to perform all QC field inspection, sampling and testing as required by this specification. All contractor personnel included in the QC operation shall be qualified by the MoDOT Technician Certification Program. Under no circumstances will unqualified personnel be allowed to perform QC sampling or testing. Personnel will be disqualified if acceptable methods and procedures are not followed.
		1. **Asphalt Test Results.** The contractor shall record all test results and furnish a copy, including all raw data, to the engineer no later than the beginning of the day following the test. The contractor shall maintain all test results in an organized format and shall be available to the QA inspector at all times. Scale readings and other measurements not directly recorded by electronic media shall be recorded in an organized format. Printouts from gyratory compactors and asphalt content devices shall be retained as part of the testing records.
	2. **Bituminous Quality Control Plan.** Prior to approval of the trial mix design by the engineer, the contractor shall submit a QC Plan to Construction and Materials for approval. The QC Plan shall include:

(a) The contractor representative in charge of QC and the project level representative if different from the contractor representative. Contact information should be recorded for these individuals.

(b) Lot and sublot sizes and how they will be designated.

(c) Performance testing, volumetrics, and asphalt content sampling, fabrication, and testing plan.

(d) The test method for determining asphalt content and density determination. If cores are to be cut, the number of cores shall be specified.

(e) Intelligent Compaction (if included in contract) and Paver Mounted Thermal Profiler base station and cellular reception plan.

(f) A proposed independent third party name, contact, address, and phone number for dispute resolution.

* + 1. **Third Party.** The third party shall be independent of the contractor, MoDOT consultants and all project subcontractors or suppliers on each specific project. All testing of material for dispute resolution shall be performed by an approved laboratory. Approved laboratories shall be AASHTO Accreditation Program certified in the areas of the material being tested.
		2. **Plant Calibration.** Plant calibration shall be performed by the contractor in accordance with Sec 404, and records shall be made available to the engineer.
		3. **Retained Samples.** All samples taken by the contractor, including but not limited to tested aggregate, volumetric and density samples, shall be retained for the engineer until the contractor’s and engineer’s tests are complete and accepted unless otherwise instructed. This includes CTIndex and RT­Index results. These samples shall be maintained in clean covered containers, without contamination, readily accessible to the engineer. The retained sample's identification shall consist of, but is not limited to:

 (a) Time and date sampled.

 (b) Product specification number.

 (c) Type of sample, i.e. belt, bin, stockpile.

 (d) Lot and sublot designation.

 (e) Sampler/Tester.

 (f) Project Job Number.

* + - 1. **Retained Loose Mix Material.** All loose mix samples for determination of volumetrics, performance tests, asphalt binder content and TSR shall be taken from the plant at random as designated by the engineer. Loose mix material shall be taken, identified, and retained for the engineer.
		1. **Performance Test Specimens and Loose Mix Sample.** All loose mix samples for determination of performance tests, volumetrics, asphalt binder content and TSR shall be taken at the plant at random intervals as designated by the engineer. All QC/QA loose mix samples shall be taken by the contractor. Non-TSR performance test specimens shall be fabricated by the contractor. The engineer shall be present when taking loose mix samples and fabricating specimens for QA testing. Companion samples shall be identified and retained for the engineer.
	1. **Quality Control Laboratory.** All QC mixture testing shall be performed in an approved laboratory.
		1. **Calibration Schedule.** The contractor shall calibrate or verify all significant test equipment associated with tests covered in this specification. Intervals as set by the contractor shall not exceed the following limits:

|  |  |  |
| --- | --- | --- |
| **Equipment - Test Method****(AASHTO)** | **Requirement** | **Interval (Month)** |
| Performance Testing Load Frames – R 18 | Calibrate | 12 |
| Hamburg Wheel Track Test - R 18 | Calibrate | 12 |
| Gyratory Compactor - T 312 | Calibrate – 1.16 ± .02° internal angle | 12a |
| Gyratory Compactor - T 312 | Verify | Daily |
| Gyratory Molds - T 312 | Check Critical Dimensions | 12 |
| Thermometers - T 209, T 166, T 312 | Calibrate | 6 |
| Vacuum System - T 209 | Check Pressure | 12 |
| Pycnometer (Flask) - T 209 | Calibrate | Daily |
| Binder Ignition Oven - T 308 | Verify | 12b |
| Nuclear Content Gauge – T 287 or MoDOT TM 54 | Drift & Stability – Manuf. Recommendation | 1 |
| Mechanical Shakers - T 27 | Check Sieving Thoroughness | 12 |
| Sieves | Check Physical Condition | 6 |
| Weighted Foot Assembly - T 176 | Check Weight | 12 |
| Mechanical Shaker - T 176 | Check Rate & Length of Throw | 12 |
| Liquid Limit Device - T 89 | Check Wear & Critical Dimensions | 12 |
| Grooving Tool - T 89 | Check Critical Dimensions | 12 |
| Ovens | Verify Temp. Settings | 4 |
| Balances | Verify | 12b |
| Timers | Check Accuracy | 6 |

aCalibrate and/or verify after each move.

bVerify after each move.

* + - 1. **Inventory.** An inventory of all major sampling, testing, calibration, and verification equipment, including the serial number or other identifying number shall be maintained.
			2. **Calibration Records.** Calibration and verification records shall include but are not limited to:

(a) Detailed results of the work performed (dimensions, mass, force, temperature, etc.)

(b) Description of the equipment calibrated including identifying number.

(c) Date the work was performed.

(d) Identification of the individual performing the work.

(e) Identification of the calibration or verification procedure used.

(f) The previous calibration or verification date and next due date.

(g) Identification of any in-house calibration or verification device used (including identification to establish traceability of items such as standard masses, proving rings, standard thermometers, balances, etc.).

* + 1. **Record Retention.** Test records shall be maintained to permit verification of any test report. Records pertaining to testing, equipment calibration and verification, test reports, internal quality systems review, proficiency sample testing, test technician training and evaluation and personnel shall be retained in a secure location for a minimum of three years.
		2. **Test Method Availability.** A current copy of all test methods and procedures shall be maintained in the QC laboratory at all times for reference by the technicians. Examples of report formats and procedures may be found in AASHTO R 18.
1. **Quality Assurance.** All QA field inspection, sampling and testing will be performed by a qualified MoDOT technician. The QA inspector shall have free access to any and all testing equipment used by the mixture producer and any workbooks, records or control charts maintained by the mixture producer for the QC process. The QA inspector shall also have sufficient access to the plant grounds to assure compliance with the approved QC Plan.
	1. **Assurance Testing.** At the plant, the contractor shall sample, condition, fabricate, and provide the CTIndex and RTIndex test specimens and provide loose mix material for all QA testing at the provided random tonnage in the presence of the engineer. The engineer will independently test the specimens and/or mixture at the frequency listed in Sec 403.19.3. The independent samples shall be of sufficient size to retain half for possible disputes.

The engineer's test results, including all raw data, will be made available to the contractor when completed and no later than the next working day.

* 1. **Core Chain of Custody.** QA density cores shall be sealed in approved tamper-evident containers immediately after extraction in the presence of the engineer.
	2. **Federal Highway Administration Requirements.** Performance and acceptance of QC/QA testing under these specifications shall not eliminate any FHWA requirements for acceptance of the material.
1. **Acceptance of Material.** Acceptance of bituminous mixture will be based on lots. With the exception of density, asphalt material will be sampled at the asphalt plant in lots or sublots on a random basis through the use of a random number system and evaluated using a Quality Level Analysis (QLA). A QLA will determine payment based on a combination of the total PWL (PWLt) determined for each pay factor item for each lot of material produced.
	1. **Random Numbers.** The engineer will generate random numbers. Random numbers will be based upon tonnage.
	2. A lot shall consist of a maximum of 6,000 tons. The maximum sublot size shall be 1500 tons and each lot shall contain no less than 4 sublots. Sublots from incomplete lots shall be combined with the previous complete lot for determination of pay factors. When no previous lot exists, the mixture shall be treated in accordance with Sec 403.23.8.1. A new lot shall begin when the asphalt content of a mixture is adjusted in accordance with Sec 403.11 or if there is an asphalt binder grade change or an additive source change.
	3. **Test and Pay Factor Items.** As a minimum, the contractor and engineer shall test in accordance with the following table. The number of random tests per sublot may be increased per the contractor’s QC plan. The QC plan shall state the test and testing frequency. All random tests shall be used in the pay factor determination. Where multiple test methods are allowed, the contractor shall designate the test method to be used in the QC Plan. Final payment will be based on the indicated pay factor items.

|  |  |  |  |
| --- | --- | --- | --- |
| **Tested Property** | **Test Method** | **Contractor Frequency** | **Engineer Frequency** |
| **Pay Factors** |
| Mat Density(% of theoretical maximum density)(a) | MoDOT TM 41, AASHTO T 166 or AASHTO T 331 | 1 Sample / Sublot  | 1 Sample / Lot  |
| Asphalt content | AASHTO T 164, or MoDOT Test Method TM-54, or AASHTO T 287, or AASHTO T 308 | 1 / Sublot |  1 / Lot  |
| Va, Ndes | AASHTO T 312 and R 35 | 1 / Sublot | 1 / Lot |
| CTIndex | ASTM D 8225 | 1 / 3000 tons | 1 / 12,000 tons |
| **Pay Factor Adjustments** |
| Unconfined Longitudinal Joint Density(a) | MoDOT TM 41, AASHTO T 166 or AASHTO T 331 | 1 Sample / Sublot  | 1 Sample / Lot  |
| Intelligent Compaction | Sec 405 | Continuous | 10% of travelway of one roller |
| RTIndex | ASTM D 8360 | 1 / 3000 tons | 1 / 12000 tons |
| Tensile Strength and TSR | AASHTO T 283 | 1 / 12000 tons (maximum) | 1 / Project |
| **Temperatures** |
| Mix Temperature at Plant | ---- | 1 / Sublot | 1 / Day |
| Temperature of Base and Air | ---- | As Needed | As Needed |

(a) Core samples shall consist of one core. Up to two additional cores, as stated in the QC Plan, may be obtained at the same offset within one foot of the randomly selected location. If more than one core is obtained, all cores shall be combined into one sample.

* + 1. **Test Method Modification.**
			1. **Binder Ignition Modification.** Asphalt content determination in accordance with AASHTO T 308, Section 6.9.1 shall be modified by adding the following: If the calibration factor exceeds 1.0 percent, lower the test temperature to 800 ± 8 F and repeat test. Use the calibration factor obtained at 800 F even if it exceeds 1.0 percent. If RAP is used, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77. At the engineer’s discretion, testing may be waived when production does not exceed 200 tons per day. The contractor shall certify the proper proportions of a previously proven mixture were used.
			2. **Rice Test.** When the water absorption of any aggregate fraction is greater than 2.0 percent, the test method for determining theoretical maximum specific gravity, AASHTO T 209, shall be modified as follows: After completing the procedure in accordance with Section 9.5.1 or 9.5.2, drain water from the sample. To prevent loss of fine particles, decant the water through a paper towel held over the top of the container. Spread the sample before an electric fan to remove surface moisture. Weigh at 15-minute intervals, and when the loss in mass is less than 0.05 percent for this interval, the sample may be considered to be surface dry. This procedure requires about 2 hours and shall be accompanied by intermittent stirring of the sample. Break conglomerations of mixture by hand. Take care to prevent loss of particles of mixture. Calculate the specific gravity of the sample by substituting the final surface-dry mass for A in denominator of Equations 2 or 3.
			3. **Mixture Bulk Specific Gravity.** Determining bulk specific gravity using paraffin-coated specimens, AASHTO T 275, shall not be used when required by AASHTO T 166. Alternate methods are AASHTO T 331 and ASTM D1188. The surface of specimens prepared for testing by these methods may have the surface texture removed by sawing a minimal amount. Specimens shall be securely held in a jig or other clamping device to eliminate distortion and retain a face parallel to the original surface. Measurements for lift thickness shall be made prior to sawing.
			4. **QC and QA Mix Sampling and Preparation.** All loose mix shall be sampled at the plant by the contractor during production in accordance with AASHTO R 97 and split to the appropriate size in accordance with AASHTO R 47. After QC has been notified of the random sample, the first truck shall be sampled as directed by the engineer. If the random number for multiple tests overlap, the contractor shall complete the first testing requirements and then immediate proceed with the second testing requirements. The contractor shall wait 30 minutes after sampling loose mix before fabricating specimens for CTIndex and RTIndex testing. Loose mix temperatures shall not drop below the molding temperature. The 30 minutes shall start when all the material for the loose mix sample has been obtained and the time this occurs shall be recorded. All specimens shall be fabricated as soon as possible after the 30 minute delay. QC and QA samples shall be taken and fabricated by the contractor at separate random times.

The following table details the minimum number of specimens required for QC or QA testing:

|  |  |  |
| --- | --- | --- |
| **Test Method** | **Minimum Number of Specimens**  | **Molded Specimen Height (mm)** |
| **Required Fabrication for CTIndex and RTIndex****QC Frequency: 1 Set per 3000 tons****QA Frequecy 1 Set per 12000 tons** |
| Cracking Tolerance Index (CTIndex) | 5 Compacted Specimens | 62 (b) |
| Rutting Tolerance Index (RTIndex) | 3 Compated Specimens | 62 (b) |
| Retained Loose Mix (a)(QA sample only) | 125 lbs | N/A |
| **Required Fabrication for Volumetrics and % Asphalt Content****QC Frequency: 1 Set per sublot****QA Frequecy 1 Set per Lot** |
| % Asphalt Content | 1 Sample | N/A |
| Theo. Max SG of mixture, Gmm | 1 Sample | N/A |
| % Air Voids | 2 Compacted Specimens | NDesign |
| Retained Loose Mix(c)  | 30 lbs | N/A |
| **Required Sampling for TSR****QC Frequeny: 1 Sample per 12,000 tons****QA Frequency: 1 Sample per Project** |
| Tensile Strength Ratio (TSR) | 250 lbs | N/A |

1. Retained loose mix for Hamburg verification of mixture not meeting minimum RTindex thresholds
2. 95 mm specimen height for SP250 mixes
3. Retain at least 30 pounds of loose mix material for dispute resolution.

The CTIndex test shall be based upon five compacted specimens tested, discard the single highest and lowest values, and average the three remaining values.

The RTIndex test shall be based upon the average of three compacted specimens.

Volumetric testing shall be based upon the average of two compacted specimens.

* + - 1. **Molding Performance Samples.** The specimens shall be compacted to an air void content of 7.0 +/- 0.5% or 6.0 ± 0.5% for SMA mixtures. The compacted test specimens shall be allowed to cool to 77 +/- 5° F prior to determining the air void content.
			2. **Records.** Compaction temperature, times in and out of the oven, gyratory specimen weights and times, and sample identification shall be recorded.
1. **Miscellaneous Applications.**
	1. **Small Quantities.** Small quantities are less than 6000 tons for the pay item quantities of each separate mixture and the following shall apply:

(a) A field laboratory will not be required for monitoring mixtures. All required QC and QA testing shall be performed in an approved laboratory.

(b) No Performance Testing is required and acceptance shall be in accordance with Sec 403.23.8.1. Density, % AC, and % Air Voids shall be performed at a frequency of no less than one per day if production does not exceed 1000 tons and at a frequency of no less than two per day if production exceeds 1000 tons. Independent or retained sample QA tests shall be performed at least once per project, as indicated.

* 1. **Base Widening and Entrances.** For base widening mixture and entrance work, the following will apply:

(a) All base widening shall be constructed in accordance with Sec 401.7 and subsections.

(b) The minimum density of these mixtures shall be attained as specified herein, except, compaction may be performed in accordance with Sec 403.15.3.

* 1. **Dispute Resolution.** When there are significant discrepancies between the engineer's and the contractor's test results, dispute resolution procedures will be used.
		1. **Cease Work.** The contractor's operations may be required to cease until the dispute is resolved if the test results indicate the mixture is subject to failure.
		2. **Third Party Resolution.** The first step in dispute resolution will be to identify differences in procedures and correcting inappropriate procedures before moving to third party resolution. If that does not resolve the dispute, either the contractor or the engineer may request the approved QC Plan third party involvement. The recommendations of the approved third party shall be binding on both the engineer and contractor.
		3. **Third Party Payment.** The contractor shall be responsible for the cost associated with the third party testing and resolution if the final result indicates the engineer's test results were correct. Likewise the Commission will be responsible for the cost associated with the third party testing and resolution when the final result indicates the contractor's results were correct.
		4. **Other Adjustments.** The contractor shall not be entitled to any additional payment for costs incurred due to use of the dispute resolution procedures such as, but not limited to, those for delay, cessation of operations, costs to subcontractors, etc. The engineer may give consideration to adjustment of working days if warranted.
		5. **Dispute with CTIndex and RTIndex ­Results.** If QA and QC results for CTIndex or RTIndex do not compare favorably, the first step will be to identify differences in procedures, including specimen aging. If that does not resolve the dispute, the QA CTIndex result shall be averaged with the QC CTIndex result to determine pay. If RTIndex  results are in dispute, QC shall fabricate specimens for Hamburg testing in the presence of the Engineer using the retained loose mix material. Retained loose mix material from the QC sample shall be used to fabricate specimens unless otherwise directed by the Engineer. Specimens shall be sent to the Engineer for Hamburg testing to determine specification compliance.
1. **General Requirements.**
	1. **Sequence of Operations.** To reduce inconvenience to the traveling public during widening or surfacing, the contractor will not be permitted to place any final surface course until the base widening, the leveling course and the binder course have been completed throughout the entire combination of sections, unless otherwise authorized by the engineer. The proper condition of the base widening, the leveling course, and the binder course, at the time of placing the surface course, shall be the contractor's responsibility.
	2. **Pavement Marking.** If the contractor's work has obliterated the existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced in accordance with Sec 620.
	3. **Surfaced Approaches.** At locations designated in the contract or as specified by the engineer, approaches shall be primed in accordance with Sec 408 and surfaced with Type SP125 asphaltic concrete. The asphaltic concrete surface shall be placed in accordance with the details shown on the plans or as specified by the engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. Any work required to condition and prepare the subgrade on the approaches will be at the contractor’s expense.
	4. **Filling Drain Basins.** If shown on the plans, existing drain basins shall be filled to the top of the lip with plant mix bituminous base course or asphaltic concrete from the pavement edge to the edge of the shoulder. Any difficulty or delay created by this requirement will be at the contractor’s expense.
	5. **Pavement Repairs (Blow-Ups).** A blow-up will be considered that area where excessive expansion has resulted in distress to the existing pavement. Blow-ups occurring prior to the application of the tack coat on the existing surface will normally be repaired by the Commission. Blow-ups occurring after the application of the tack coat shall be repaired by the contractor by removing the distressed concrete and replacing the pavement in accordance with Sec 613.
2. **Method of Measurement.**
	1. **Weight Determination.** The weight of the mixture will be determined from the batch weights if a batch-type plant is used, and will be determined by weighing each truck load on scales in accordance with Sec 310 if other types of plants are used. Measurement will be made to the nearest 0.1 ton for the total tonnage of material accepted.
	2. **Full Depth.**
		1. The final driving surface area, for the full depth of the pavement, will be used as the area for all underlying bituminous lifts and will not include the additional quantity needed to construct the 1:1 slope.
		2. Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of the pavement complete in place will be made to the nearest 0.1 square yard. The revision or correction will be computed and added to or deducted from the contract quantity.
	3. **Alternate Overlay.**
		1. **Field Established Quantity.** When bid as an alternate to a Portland cement concrete overlay, the contractor shall establish the existing roadway profile and set the final overlay profile. The engineer may adjust the final profile as needed. The tons of hot mix asphalt required will be determined by the engineer from the set or adjusted profile. This quantity will be the field established plan quantity.
		2. **Overlay Measurement.** Final measurement of the completed pavement will be based on the field established plan quantity except for authorized changes during construction. The revision or correction will be computed and added to or deducted from the contract quantity. Measurement of the pavement complete in place will be made to the nearest 0.1 ton.
	4. **Pavement Testing.** The finished courses shall have the nominal thickness shown on the plans. Tests will be conducted to ensure that each course is being constructed to proper thickness, composition, and density. The contractor shall cut samples from any layer of the compacted mixture at locations designated by the engineer. QA samples shall be cut and delivered to the engineer no later than the end of the next day following the laydown operation. If the samples are not cut and delivered as stated, the asphaltic laydown operation may be suspended and a deduction of 5 percent per day of the contract unit price of the representative material may be applied, until samples are cut and delivered to the engineer. Samples may be obtained by either sawing or drilling 4-inch minimum diameter cores. Each sawed sample shall consist of a single piece of the pavement of the size designated by the engineer, but no larger than 12 inches square.
		1. **Pavement Thickness.** Lift thickness may be determined by the average thickness of cores taken for density measurements for each lot. Total thickness samples for new full depth asphalt pavements shall be obtained after all bituminous construction is completed on the project and shall be taken at locations specified by the engineer. For the purpose of determining the constructed thickness of full depth pavement, cores shall be taken at random intervals in each traffic lane at the rate of one core per 1000 feet or increment thereof, or at any other locations as may be determined by the engineer and measured in accordance with AASHTO T 148. Sections of any asphaltic concrete determined to be 0.5 inches or more, less than the thickness shown on the plans, shall be corrected by the contractor. No payment will be made for any costs incurred by the contractor in correcting pavement deficient in thickness. Each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement.
		2. **Surface Restoration.** The surface from which samples have been taken, including those for density measurements, shall be restored by the contractor with the mixture then being produced no later than the next day of plant operation, if construction is still active. If bituminous construction has been completed, the surface from which samples have been taken shall be restored within 48 hours with an approved commercial mixture or with cold patch mixtures acceptable to the engineer.
3. **Basis of Payment.**
	1. **Percent Within Limits.** PWL will be based on the mean, standard deviation and quality index of each lot's test results. The upper PWL (PWLu) and lower PWL (PWL1) is determined from the table in Sec 502.15.8. For Upper or Lower Quality Index values less than zero, the value in the Table shall be subtracted from 100. Total percent within limits, PWLt, is: PWLt = (PWLu + PWL1) - 100. For Density of SMA mixes the PWLu shall be 100.

 The mean is: xa = (Ʃx*i*)/n

 Where: xa = Average of the individual values being considered

 Ʃx*i* = The summation of all the individual values being considered

 n = The number of individual values under consideration

 The Standard Deviation is: s = (Ʃ(xi - xa)2/(n - 1))1/2

 The Upper Quality Index is: Qu = (USL - xa)/s

 The Lower Quality Index is: Q1 = (xa - LSL)/s

 Where: Qu = Upper Quality Index

 Q1 = Lower Quality Index

 USL = Pay Factor Item Upper Spec Limit

 LSL = Pay Factor Item Lower Spec Limit

* + 1. **Quality Level Analysis.** The engineer will make the QLA no more than 24 hours after receipt of the contractor's test results, by determining the PWLt for each designated pay factor item.
			1. **Acceptance.** The contractor's test results will be used when applicable to determine the PWL, provided the contractor's QC tests and the engineer's QA tests compare favorably, and provided the engineer's inspection and monitoring activities indicate the contractor is following the approved QC Plan.
			2. **Comparison.** Favorable comparison will be obtained when the engineer's QA test results on a production sample are within two standard deviations or the comparison limit, whichever is greater, of the mean of the contractor's test results for that particular lot. Comparison limits for QC average results are as follows: air voids within ±0.5 percent, asphalt content within ±0.2 percent, and density within ±1.3%. QA CTIndex results shall be within ± 30 of the QC testing that falls nearest result for SuperPave and ± 60 for SMA. For the CTIndex test, if all QC and QA are greater than 80 for SuperPave mixes and greater than 190 for SMA mixes, then results are considered comparable. QA RTIndex results shall be within ±15 percent of the QC testing that falls nearest. Further comparisons may be made by using F & t testing at a significance level of 1 percent as directed by the engineer.
			3. **Outliers.** No test result shall be discarded, except individual test results on a lot basis may be checked for an outlier in accordance with the statistic T in ASTM E 178, at a significance level of 5 percent. If an outlier is found, material from the retained QA sample may be tested, in the presence of the engineer, to determine a replacement test value. The replacement test value shall be used in the PWL determination.
			4. **Roadway/Shoulder Lots.** For the purpose of QLA, mixture placed on the traveled way and placed on the traveled way and shoulders integrally, shall be accounted for in a regular lot/sublot routine. Mixture placed on shoulders only shall be accounted for in a shoulder lot/sublot routine.
			5. **Random Sampling.**  For the purpose of QLA, all mixture produced at the plant and placed on the roadway shall be subject to random testing. Mainline density measurements at the roadway shall not be taken within 6 inches of an unconfined longitudinal joint. Random samples taken in the same day may be separated by 200 tons.
	1. **Pay Factors.** The total pay factor (PFT) for each lot will be equal to the weighted sum of the pay factors (PF) for each pay factor item for each lot, and is determined as follows:

PFT = + (0.5) PFDensity + (0.25) PFVa + (0.25) PFAC

The PFT for each lot, on the shoulder or otherwise when the density pay factor is not directly included, will be equal to the weighted sum of the PF for each pay factor item for each lot, and will be determined as follows:

PFT = (0.5) PFVa + (0.5) PFAC

The PF for each pay factor item for each lot will be based on the PWLt of each pay factor item of each lot and will be determined as follows:

When PWLt is greater than or equal to 90: PF = 0.3 PWLt + 73;

When PWLt is greater than or equal to 70 and PWLt is less than 90: PF = 0.5 PWLt + 55;

When PWLt is less than 70: PF = 2 PWLt – 50;

* + 1. **Density Pay Factor.** The theoretical maximum specific gravity of the mixture, as determined for each sublot and the bulk specific gravity of no less than one core from each sublot, will be used to perform the QLA for the percent of theoretical maximum density. Thick cores required to be cut in half in accordance with Sec 403.15.4 shall effectively double the number of sublots for cores. When density is not used as a pay factor, additional adjustment of the contract unit price will be based on the table in Sec 403.23.8.1.
		2. **Asphalt Content Pay Factor.** The QLA will be performed using the asphalt content test results from each lot.
		3. **Air Voids Pay Factor.** Two gyratory specimens shall be compacted for each sublot and the average of the two specimens will be used to calculate the volumetrics of the sublot. The air voids shall be determined from the gyratory compacted specimens. The air voids for the QLA shall be those calculated using the average bulk specific gravity of the gyratory compacted specimens and the theoretical maximum specific gravity of the mixture determined for the sublot of material.
		4. **CTIndex and TSR Pay Factor.** The contract unit price for each 3,000 tons or fraction thereof for all mixtures shall be adjusted based on the average CTIndex results for the tonnage according to the following table provided that acceptable RTIndex or Hamburg and TSR results are obtained. The lower adjusted contract unit price from the CTIndex and TSR results shall apply.

|  |
| --- |
| **SuperPave Mixtures** |
| **Cracking Tolerance Index (CTIndex)** | **Tensile Strength Ratio (TSR)(a)** | **Percent of Contract Price** |
| 40 – 49 | 70 – 74 % | 97% |
| 50 – 99 | 75 – 84 % | 100% |
| 100 or Greater | 85 % or Greater | 103% |
| **SMA Mixtures** |
| **Cracking Tolerance Index (CTIndex)** | **Tensile Strength Ratio (TSR)(a)** | **Percent of Contract Price** |
|  80 – 134 | 70 – 74 % | 97% |
| 135 – 239 | 75 – 84 % | 100% |
| 240 or Greater | 85 % or Greater | 103% |

(a) If an approved liquid anti-strip is used, the TSR limit to receive full incentive is 80 %.

The QLA shall be performed using each Density, % Air Void, and % Asphalt Content result within the lot.

* 1. **Removal of Material.** All lots of material with a PFT less than 50.0 shall be removed and replaced with acceptable material by the contractor.

Any sublot of material with a percent of theoretical maximum density of less than 90.5 percent or greater than 98.5 percent shall be removed and replaced with acceptable material by the contractor. For SMA mixtures, any sublot of material with a percent of theoretical maximum density of less than 92.0 percent shall be removed and replaced with acceptable material by the contractor.

Any material with a CTIndex less than 40 shall be removed and replaced with acceptable material by the contractor. For SMA mixtures, any material with a CTIndex less than 80 shall be removed and replaced with acceptable material by the contractor.

Any sublot of material with air voids in the compacted specimens less than 1.5 percent or tonnage of material not meeting the minimum RTIndex shall be evaluated with Hamburg testing and removed and replaced with acceptable material by the contractor if the rut depth is greater than 1/2-inch at the designated number of wheel passes.

Any material with TSR results below 70% or minimum conditioned tensile strength below 60 psi are considered unacceptable and will be subject to removal, production shall cease, the mixture reverified, and other payfactors incentives shall not be applied.

No additional payment will be made for such removal and replacement. The replaced material will be tested at the frequencies listed in Sec 403.19. Pay for the material will be determined in accordance with the applicable portions of Sec 403.23 based on the replacement material.

* 1. **Pay Factor Adjustments.** If any payment reductions are necessary, the lower adjusted contract unit price of the total payfactor (PFT) and unconfined longitudinal joint density adjustment will apply. Intelligent Compaction (IC) adjustment (if required by contract) may affect PFDensity. Pay factor adjustments are as follows:
		1. **Unconfined Longitudinal Joint Density Adjustment.** The minimum density of all traveled way pavement within 6 inches of a longitudinal joint, including the pavement on the traveled way side of the shoulder joint, shall not be less than 90.5 percent of the theoretical maximum specific gravity for SuperPave mixtures and above 92.0 percent of the theoretical maximum specific gravity for SMA mixtures. The density of the longitudinal joint when confined will be included in the evaluation of the remainder of the mat. Pay adjustments will be in accordance with the following table and will be applied to the corresponding tonnage represented by the core(s).

Pay adjustments due to longitudinal joint density will apply to the full width of the lane paved. The average of joint cores from each sublot will determine specification compliance. If payment reductions are necessary, the lowest PFTotal shall apply. Adjustments due to joint density will apply to the sublot from which the cores are obtained.

|  |
| --- |
| **Longitudinal Joint Density** |
| Field Density (Percent of Laboratory Max. Theoretical Specific Gravity) | Percent of Contract Unit Price |
| SuperPave Mixtures |
| > 90.5 | PFTotal not changed by longitudinal joint density |
| 89.5 – 90.4 | Maximum PFTotal = 100%; Correction Required(a) |
| < 89.5 | Remove and Replace |
| SMA Mixtures |
| > 92.0 | PFTotal not changed by longitudinal joint density |
| 90.0 – 91.9 | Maximum PFTotal = 100%; Correction Required(a) |
| < 90.0 | Remove and Replace |

1. Correction requires spraying rapid penetrating emulsion on deficient density areas in accordance with JSP2303. All costs associated with correction shall be at the contractor’s expense with no additional payment.
	* 1. **Intelligent Compaction Adjustment.** When Intelligent Compaction is included as a pay item in the contract, sublots shall have a minimum of 85 % roller coverage and a mean temperature above 180 °F at the optimum number of roller passes of the traveled way. Pay adjustments will be in accordance with the following table and will be applied to the corresponding sublot that falls within the corresponding IC segment:

|  |
| --- |
| **Intelligent Compaction** |
| Percent Roller Coverage at Optimum Pass Count | Percent of Contract Unit Price |
| > 85 % | Payment adjustment due to intelligent compaction does not apply |
| < 85 | Verify core density in accordance with Sec 405 |

If roller coverage is less than 85%, the lower adjusted contract unit price of the PWL or unconfined joint density adjustment will apply. Adjustments due to roller coverage will apply to the corresponding sublots. The roller coverage per sublot shall be the average roller coverage for the days the sublot was paved weighted by the tons paved per day.

Any sublot with roller coverage less than 70 percent shall be subject to the core density verification as directed by the engineer. Pay adjustments shall be in accordance with Sec 405.

* + 1. **Smoothness Adjustment.** The contract unit price for all mixes, except wedge or level course, will be adjusted in accordance with Sec 610.5. The contract unit prices for asphaltic concrete pavement will be considered full compensation for all materials entering into the construction of the pavement and for the cost of the smoothness testing and correction.
		2. **Paver Mounted Thermal Profiler.** The contract unit price for all mixes, except wedge or level course, will be adjusted in accordance with Sec 406. The contract unit prices for asphaltic concrete pavement will be considered full compensation for all materials entering into the construction of the pavement and for the cost of the PMTP testing and correction.
		3. **Intelligent Compaction.** If Intelligent compaction is not included as a pay item in the contract, then all specification requirements and pay adjustments pertaining to Intelligent Compaction will not apply. If pay items for Intelligent Compaction are included in the contract, then all specification requirements and pay adjustments pertaining to Intelligent Compaction shall apply.
	1. **Aggregate Variation.** Due to possible variations in the specific gravity of the aggregates, the tonnage of mixture used may vary from the proposal quantities. No adjustment in contract unit price will be made because of such variation.
	2. **Compacted Samples.** Payment for obtaining and delivering samples of compacted mixture from the pavement and replacing the surface will be made per sample at the fixed price specified in Sec 109. No direct payment will be made for samples taken for QC and QA testing.
	3. **Payment for Pavement Repairs (Blow-ups).** Payment for repairing blow-ups will be made in accordance with Sec 104.
	4. **Miscellaneous Applications.**
		1. **Small Quantities.** Small quantities are defined in Sec 403.20.1. Unless the contractor has elected to use the normal evaluation in the Bituminous QC Plan for small quantities, the following shall apply for each separate mixture qualifying as a small quantity

(a) QLA and PWL shall not apply.

(b) Mixtures shall be within the specified limits for % Air Voids, % AC, and density. In addition to any adjustments in pay due to profile, the contract unit price for the mixture represented by each set of cores will be adjusted based on actual field density above or below the specified density using the following schedule:

|  |  |
| --- | --- |
| **Field Density****(Percent of Laboratory Max. Theoretical Density)** | **Pay Factor****(Percent of Contract Unit Price)** |
| **For all SP mixtures other than SMA:** |  |
| 92.5 to 98.0 inclusive | 100 |
| 90.5 to 92.4 inclusive | Correction(a) |
| Above 98.0 or Below 90.5 | Remove and Replace |
| **For SMA mixtures:** |  |
| >94.0 | 100 |
| 92.0 to 93.9 inclusive | Correction(a) |
| Above 98.0 or Below 92.0 | Remove and Replace |

1. Correction requires spraying rapid penetrating emulsion on deficient density areas in accordance with JSP2303. All costs associated with correction shall be at the contractor’s expense with no additional payment.
	* 1. **Base Widening and Entrances.** For base widening mixtures and entrance work, QLA and PWL will not be required. Payment for these mixtures will be made at 100 percent of contract unit price for material that otherwise meets the specifications.
		2. **Single Lift on Unmilled Surface or Leveling Course Work.** For resurfacing projects specifying a single lift on an unmilled surface, surface mixture of 3,000 tons or more, or for leveling course work, the following shall apply to the traveled way mixture. All bituminous mixture QC/QA requirements shall apply, except the density pay factor designated in Sec 403.23.2 will not be directly included in the total pay factor. In lieu of that, one density sample shall be taken per sublot and the pay adjustment for density will be made using the table in Sec 403.23.8.1.

**3.0** *Insert Sec 406 Paver-Mounted Thermal Profiles:*

**406 Paver-Mounted Thermal Profiles**

**406.1 Description.** This work shall consist of continuous thermal profiling of the asphalt mat temperature behind the trailing edge of the paver screed plate during placement operations using a Paver-Mounted Thermal Profile System (PMTPS). This work shall be completed in accordance with the general principles set forth in AASHTO R 110 “Standard Practice for Continuous Thermal Profile of Asphalt Mixture Construction”, and specifically as stated in the following sections.

**406.2 Required Measurements.** PMTPS measurements are required on the full width of paving of each asphalt lift. Collection of data shall include shoulder pavement when placed simultaneously with the mainline. The shoulder paving data will be filtered out using Veta during data processing. PMTPS data collection is not required in the following exceptions:

1. PMTPS measurements are not required on auxiliary lane tapers, ramps, shoulders (not paved simultaneously with mainline), cross-overs, non-continuous turn lanes, loops, bypass lanes, acceleration/deceleration lanes, intersecting streets, roundabouts, and partial lane width widenings.
2. PMTPS measurements are not required for a total net paving length less than 2 lane miles.
3. PMTPS measurements are not required on asphalt lift thicknesses less than 1-inch.

**406.3 Equipment Requirements.** The PMTPS shall consist of the following components listed.

1. Temperature sensor to continuously monitor surface temperature of mat.
	1. Longitudinal and lateral surface temperature readings shall be collected at 12-inch or less intervals at all paving speeds with an X-Y accuracy of plus or minus 1-inch.
	2. Surface temperatures shall be collected for the full width paved in one pass (including any shoulders paved simultaneously with mainline).
	3. Surface temperature sensors(s) shall have a temperature range of at least 140 °F to 480 °F. Sensory accuracy shall be plus or minus 3.6 °F, or plus or minus 2.0 percent of sensor reading, whichever is greater.
2. Global Navigation Satellite System (GNSS) receiver to capture coordinates of the surface temperature readings. GNSS accuracy shall be plus or minus 2 inches or less in X and Y directions when intelligent compaction is being used. A base station shall be required at any locations having poor cellular reception to obtain required accuracy. When intelligent compaction is not being used GNSS accuracy shall be plus or minus 4 ft or less in the X and Y directions and ground distance sensor shall be within plus or minus 1/1000 ft.
3. Onboard data acquisition with a minimum of the following capabilities:
	1. Displays (in real-time) map of the surface temperature readings.
	2. Displays total distance, paver speed and location.
	3. Reports surface temperature readings and GNSS status.
	4. Provides real-time statistical summaries of surface temperature readings.
	5. Allows operator to define data lot currently being placed per AASHTO PP 114.
	6. Stores data internally until data transfer.
	7. Automatically transfers data to cloud storage or other approved methods.

**406.3.1 System Setup on Pavers.** Pavers shall be instrumented with the PMTP system for the full paving width and shall collect measurements no less than 3-feet and no greater than 12-feet from the trailing edge of the screed plate. Other objects shall not obstruct surface temperature measurements and GNSS accuracy.

**406.4 Construction Requirements**.

**406.4.1 Temperature Verification.** Temperature verification shall follow AASHTO R110-22, Section 6 Calibration. A record of each verification shall be submitted to the SharePoint prior to the start of the project.

**406.4.2 Data Management.** PMTP data files shall be compatible with the Veta software. The contractor shall supply the engineer with the manufacturer’s PMTPS Computer Software 14 days prior to beginning work and until ninety days after completion of all work. If Cloud Storage or Cloud Computing is used, the engineer shall be supplied one user ID with full access for the same time-period specified. If cloud storage is not used Raw PMTP data files shall be downloaded once per day and uploaded to the appropriate MoDOT IC-PMTP SharePoint site before the start of the next day’s production. The following data management requirements shall apply:

1. The PMTP data files should be directly transferred from cloud storage to Veta. Other methods shall be approved by the engineer.
2. The PMTP Veta files shall be appropriately formatted and filtered in accordance with MoDOT IC-PMTP protocol.
3. Date and time stamp of PMTP shall be checked and verified to reflect the local time zone for both mapped and exported data.

**406.4.3 Quality Control.** The following shall apply to the Contractor’s Quality Control for PMTP.

* 1. The contractor shall have a properly trained person listed in the QC Plan that has completed a Veta training course within the last 2 years to perform the PMTP data collection and file management for the project.
	2. The PMTP system shall have a documented annual calibration before beginning construction.
	3. For each run, the thermal profile shall be divided into 150-foot sublots at the full paving width and partial data sublots as follows:
		1. Combine partial data sublots less than 75-feet with the previous data sublot.
		2. Treat partial sublots greater than 75-feet as one data sublot.
		3. Sublots shall not extend over multiple days, different lifts, or paving directions.
	4. Veta files shall be completed and uploaded with the appropriate naming convention in accordance with MoDOT IC-PMTPS Protocol. Appropriate naming convention can be found in the IC-PMTP Document Helper located in the [Intelligent Compaction SharePoint site](https://partner.modot.mo.gov/sites/cm/IntellComp/SitePages/Home.aspx). The completed Veta files shall have the appropriate filters applied with the summary data transferred to the Summary Report. An up-to-date Summary Report shall be provided to the engineer two days prior to the 1st and 15th of each month.
	5. **PMTP Quality Control Plan**. A pre-activity meeting shall be required prior to mainline paving. The PMTP Quality Control Plan shall be submitted to the engineer at least 2 weeks prior to the mainline paving pre-activity meeting. The plan at minimum shall include the following:

(a) A list of personnel previously trained

(b) Detailed daily verification procedure for checking the RTK-GNSS of PMTP

(c) Procedure for downloading PMTP data from the instrument

(c) The procedure for training operators or other project staff

(e) Detailed daily verification procedure for checking the temperature sensor on the PMTP

(f) The name of the designated PMTP Quality Control Technician

(g) Procedure for submitting data

(h) Contact information for technical support staff

(i) Anticipated cellular service and GNSS coverage throughout entire project

(j) A list of the control points with either UTM or State Plane Coordinates established by the contactor if a base station is required.

**406.4.4 Quality Assurance (QA) Testing.** The Engineerwill use a Forward Looking InfraRed (FLIR) camera to verify the contractor’s PMTP system. QA tests shall be taken at random locations twice per day. The contractor shall assist the engineer with the placement of the event marker.

The QA tests using the FLIR data QA tool shall compare favorably, according to the instructions found in the IC-PMTP Document Helper located in the [Intelligent Compaction SharePoint site](https://partner.modot.mo.gov/sites/cm/IntellComp/SitePages/Home.aspx). If results do not compare favorably, the contractor’s PMTPS shall be verified by the manufacturer. In the case that the PMTPS is required to be sent off to the manufacturer and the contractor is not able to provide a replacement, the contractor will be allowed to continue paving with the verification by the engineer using a FLIR camera for acceptance only.

**406.4.5 Thermal Segregation.** Thermal segregation will be calculated by using the Differential Range Statistics (DRS) under the parameters of AASHTO R110 in each 150-foot sublot.

The Veta analysis with the appropriate filters applied shall exclude the following surface temperature readings from each sublot:

1. Surface temperature readings less than 180°F.
2. Surface temperature readings within 2 ft. prior to and 8 ft. after paver stops that are greater than 1 minute in length.

The thermal segregation categories are based on the Differential Range Statistics (DRS), as shown in the table below.

|  |  |
| --- | --- |
| **Differential Range Statistics (DRS)**  | **Thermal Segregation Category** |
| DRS ≤ 25.0°F | Low |
| 25°F < DRS ≤ 35°F | Moderate |
| 35°F < DRS ≤ 50°F | Moderate-High |
| DRS ≥ 50°F | Severe |

**406.4.6.1 Incentive/Disincentive.** Incentive/disincentive adjustments shall be made for each sublot in accordance with the following:

|  |  |
| --- | --- |
| **Thermal Segregation Category** | **Adjustment per 150 ft. Sublot** |
| Low | $40 Incentive |
| Moderate | $40 to $0 Incentive (Linear) |
| Moderate-High | $0 to -$40 Disincentive (Linear) |
| Severe | -$40 Disincentive and Reviewed by Engineer |

**406.5 Loss of Data**. If data collection ceases as a result of circumstances reasonably beyond the control of the contractor, the contractor will be allowed to continue the days paving, but the paved sublots will not be eligible for 406 PMTP Incentive. The engineer must be notified immediately of the issue and shall determine if the contractor has made a reasonable effort to resolve the issue. A meeting with the engineer shall be held to determine how to proceed if the issue is expected to extend into the next day’s paving. Failure to notify the engineer of the issue at hand will result in the paved sublots to receive a minus $40 deduct.

**406.5.1 GNSS Obstructions**.A base station shall be used at any locations having poor cellular reception. Isolated areas influenced by a GNSS obstruction may be excluded from DRS computation provided that the following conditions are satisfied:

1. The position data is present
2. The GNSS Reception Mode as recorded by the onsite equipment indicates that an obstruction is present
3. The location is properly flagged in the Veta project file and the location is identified in the bi-weekly report
4. The total of these areas is no more than 5% of any single day’s production.

**406.5.2 QA Acceptance.** When PMTP data is not available, paved sublots will be accepted by verification using the FLIR camera. Temperature differentials greater than 50°F are subject to removal.

**406.6 Basis of Payment.** No direct payment will be made for compliance with this provision.