

SUPERPAVE ASPHALTIC CONCRETE

Section 1028 in the Standard Specifications is amended to provide that Asphaltic Concrete, Type shall use the gradation band.

SECTION 1028 - SUPERPAVE ASPHALTIC CONCRETE (J-7-1013)

Section 1028 in the Standard Specifications is void and superseded by the following:

1028.01 -- Description

1. a. Superpave Asphaltic Concrete is a Contractor-designed mix.
- b. The Contractor shall be required to define properties using a gyratory compactor that has met the Superpave evaluation test procedures, during mix design and production.
2. Job Mix Formula
 - a. Before production of asphaltic concrete, the Contractor shall submit, in writing, a tentative Job Mix Formula (JMF) on the NDOR Mix Design Submittal Form for verification to the Department.
 - b. The JMF shall be determined from a mix design for each mixture. A volumetric mixture design in accordance with AASHTO R 35 as modified within this specification will be required. However, the mixture for the Superpave specimens and maximum specific gravity mixture shall be aged for two hours at compaction temperature. The mixture shall be prepared using the following:
 - (1) Mixture Conditioning of Hot Mix Asphalt (HMA), AASHTO R 30.
 - (2) Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of the SHRP Gyratory Compactor, AASHTO T312.
 - c. The JMF shall identify:
 - (1) The virgin mineral aggregates and pit locations
 - (2) Recycled Asphalt Pavement (RAP) and source locations
 - (3) Hydrated lime
 - (4) Mineral filler
 - (5) The percent passing value for each specified sieve for the individual and blended materials
 - d. (1) The Contractor shall submit one uncoated, proportioned 22 lb. (10,000 gram) sample of the blended mineral aggregates for consensus properties and specific gravity testing, for all mix types except SPS. Once verified, the Contractor may begin plant production and QC testing with the QA/QC program.

- (2) The Contractor has the option of submitting the following; 2 proportioned 22 lb. (10,000 gram) samples of the blended mineral aggregates (which are precoated with hydrated lime, if lime is used) and two one-quart (liter) samples of the proposed PG Binder to be used in the mixture to the Department Materials and Research Central Laboratory at least 15 NDR working days before production of asphaltic concrete. If submitted these samples will be used to verify the Contractor's Superpave mix design test results and mix properties.
 - (3) Submitted with these samples shall be a copy of the Contractor's results for all Superpave mix design tests.
 - (4) Mix design shall include at a minimum:
 - (i) The bulk specific gravity (Gsb), which shall be 2.585, for data purposes and as information only, for all mixes.
 - (ii) The target binder content. The binder content will be determined by ignition oven results. A correction factor of 0.3% will be added to the ignition oven results for mixes containing hydrated lime, and an adjustment factor of 0.1% will be added to the ignition oven results for mixes containing WMA.
 - (iii) The supplier and grade of PG Binder.
 - (iv) The maximum specific gravity of the combined mixture (Rice).
 - (v) The bulk specific gravity (Gmb) and air voids at N initial (Nini), N design (Ndes) and N maximum (Nmax) of the gyratory compacted specimens.
 - (vi) Voids in the Mineral Aggregate (VMA) and Voids Filled with Asphalt (VFA) at Ndes.
 - (vii) Fine Aggregate Angularity (FAA) and specific gravity, Coarse Aggregate Angularity (CAA), Flat and Elongated Particles and Sand Equivalent of the aggregate blend.
 - (viii) Location description and/or legal descriptions and producers of materials used in the mix.
 - (ix) Dust to Binder Ratio.
 - (x) JMF compaction temperatures from NDOR Gyratory Temperature Table (See Table 1028.11).
 - (xi) The hydrated lime content.
3. Quality Control Program:
- a. The Contractor shall establish, provide, and maintain an effective Quality Control (QC) Program. The QC Program shall detail the methods and procedures that will be taken to assure that all materials and completed construction conforms to all contract requirements.

- b. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the contract, the Contractor shall assume full responsibility for placing a pavement course that meets the target field values.
- c. The Contractor shall establish a necessary level of control that will:
 - (1) Adequately provide for the production of acceptable quality materials.
 - (2) Provide sufficient information to assure both the Contractor and the Engineer that the specification requirements can be met.
- d.
 - (1) The Contractor shall develop and submit a copy of their QC Program to the Department. A copy of the QC Program shall be kept on file in the QC lab trailer. This Program shall be updated as needed and submitted annually for review.
 - (2) The Contractor shall not begin any construction or production of materials without an approved QC Program.
- e. The QC Program shall address, as a minimum, the following items:
 - (1) QC organization chart.
 - (2) Inspection requirements.
 - (i) Equipment.
 - (ii) Asphalt concrete production.
 - (iii) Asphalt concrete placement.
 - (3) QC testing plan.
 - (4) Documentation of QC activities.
 - (5) Requirements for corrective action when QC or acceptance criteria are not met.
 - (6) Any additional elements deemed necessary.
 - (7) A list, with the name and manufacturers model number, for all test equipment used during laboratory testing.
 - (8) A description of maintenance and calibration procedures, including the frequency that the procedures are performed.
- f. The QC organization chart shall consist of the following personnel:
 - (1) A Program Administrator:
 - (i) The Program Administrator shall be a full-time employee of the Contractor or a Subcontractor (Consultant) hired by the Contractor.
 - (ii) The Program Administrator shall have a minimum of 5 years' experience in highway construction.
 - (iii) The Program Administrator need not be on the job site at all times but shall have full authority to institute any and all

actions necessary for the successful implementation of the QC Program.

- (iv) The Program Administrator's qualifications and training shall be described in the QC Program.
- (2) Quality Control Technicians:
 - (i) The quality control technicians shall report directly to the Program Administrator and shall perform all sampling and quality control tests as required by the contract.
 - (ii) The QC technicians shall be certified every 5 years by the Department Materials and Research Division.
 - (iii) Certification at an equivalent level by a state or nationally recognized organization may be acceptable.
 - (iv) The QC technician's credentials and training records shall be submitted to the Department.
 - (v) The Contractor may have a non-certified technician working under the direct supervision of a certified technician for no more than one construction season.
- g. (1) Inspections shall be performed daily to ensure continuing compliance with contract requirements until completion of the work.
- (2) QC test results and periodic inspections shall be used to ensure the mix quality and to adjust and control mix proportioning.
- 4. Contractor's Lab Equipment:
 - a. The Contractor shall calibrate and correlate the testing equipment according to the procedures prescribed for the individual tests and conduct tests in conformance with specified testing procedures.
 - b. The Contractor shall have the following equipment (or approved equal) at or near the project location:
 - (1) A gyratory compactor and molds meeting AASHTO criteria.
 - (2) An Asphalt Content Ignition Oven meeting AASHTO criteria.
 - (3) Rice equipment specified in AASHTO T 209, procedure 9.5.1, Weighing in Water. The thermometer being used to measure water temperature will be as specified in T 209.
 - (4) FAA equipment specified in AASHTO T304.
 - (5) To test density of compacted asphaltic concrete, a minimum 6000 gm balance, 0.1 gm resolution, with under body connect and water container large enough to conveniently place specimen in the basket and completely submerge the basket and specimen without touching the sides or bottom is required.
 - (6) QC Laboratory which contain the following:
Air conditioner.

Dedicated phone.
FAX machine or email.
Photocopy machine.
Sample storage.
Work table.
Bulletin board.
Running water.
Desk and chair.
Separate power supply.
Incidental spoons, trowels, pans, pails.

- (7) Diamond saw for cutting cores.
- (8) Diamond core drill minimum 3 inch (75 mm).
- (9) Oven, 347°F (175°C) minimum, sensitive plus 5°F (plus 2°C).
- (10) USA Standard Series Sieves for coarse and fine aggregate with appropriate shakers (12 inch (300 mm) recommended).
- (11) Personal Computer capable of running the latest version of Department Superpave software, creating an electronic copy of the data, and printing to a Color Printer.

5. QC Testing Plan:

- a. The testing plan shall provide that the samples be collected in accordance with the Department statistically based procedure of random sampling.
- b. The Contractor may add any tests necessary to adequately control production.
- c. All QC test results shall be reported on the latest version of the Department's provided Superpave software by the Contractor with a copy provided to the Engineer within 1 week after the tests are complete. Daily review by the Engineer shall be allowed. At the completion of the asphalt production, the Contractor shall submit to the Department a final copy of the Superpave test results on electronic recording media (CD, e-mail, flash drive, etc.).
- d. Corrective Action Requirements:
 - (1) The Contractor shall establish and utilize QC charts for individual QC tests. The requirements for corrective action shall be linked to the control charts.
 - (2) The Contractor's QC Program shall detail how the results of QC inspections and tests will be used to determine the need for corrective action.

- (3) (i) A clear set of rules to determine when a process is out of control and the type of correction to be taken to regain process control will be provided.
- (ii) As a minimum, the plan shall address the corrective actions that will be taken when measurements of the following items or conditions relating to the mixture approach the specification limits:
 - (I) Plant produced mix gradations at laydown (See gradation tolerances).
 - (II) Binder content.
 - (III) Air voids.
 - (IV) VMA (mix design only).
 - (V) VFA (mix design only).
 - (VI) FAA AASHTO T 304.
CAA ASTM D 5821.
 - (VII) Dust to Binder Ratio.
 - (VIII) Density.
 - (IX) Contaminates.
- (iii) Corrective actions that will be taken when the following conditions occur:
 - (I) Rutting.
 - (II) Segregation.
 - (III) Surface voids.
 - (IV) Tearing.
 - (V) Irregular surface.
 - (VI) Low Density.

1028.02 -- Material Characteristics

1. The type of PG Binder will be shown in the contract.
2. Recycled Asphalt Pavement:
 - a. The Contractor may submit to the State a proposal to supplement the virgin aggregates of the asphaltic concrete mix with a Contractor's specified percentage of Recycled Asphalt Pavement (RAP). The Contractor is responsible for investigating and maintaining the quality and verifying the quantity of the RAP material.
 - b. In recycled asphaltic concrete mixtures, the allowable percent of RAP will be as shown in Table 1028.01.

Table 1028.01

Asphaltic Concrete Type	Percent, RAP	
	Minimum	Maximum
SPS	0	55
SPR	0	55
SPH	0	35

3. Aggregates:
- a. Aggregates for use in superpave asphaltic concrete shall be tested on an individual basis.
 - b. With the exception of Asphaltic Concrete Type SPS the blended mineral aggregate shall not contain more than 80% limestone on the final surface lift of asphaltic concrete.
 - c. Asphaltic Concrete Type SPR may contain a total maximum of 10% of the virgin material that is composed of natural, uncrushed aggregate by manmade methods commonly known as but not limited to: 47B gravel, 2A gravel, gravel surfacing, sluice sand, blow sand, waste sand, fill sand, road gravel, roofing gravel, hot mix sand or gravel, coarse sand, fine sand, plaster sand, masonry sand, pit run sand or gravel. For clarification on any proposed gravel, contact the Department Flexible Pavements Engineer.
 - d. Chat or coal sand will not be allowed in any mix.
 - e. Crushed rock material for use in asphaltic concrete, 1/4 inch (6.35 mm) and smaller, screenings and manufactured sand shall have a Sodium Sulfate loss of not more than 12% by mass at the end of 5 cycles. Sampling size and frequency shall adhere to the current Department Materials Sampling Guide.
 - f. Quartzite and granite shall conform to the requirements of Subsection 1033.02, Paragraph 4, a. (8). Sampling size and frequency shall adhere to the current Department Materials Sampling Guide.
 - g. Crushed rock (Limestone) and Dolomite shall conform to the requirements of Paragraph 4.a. (4), (5) and (6). of Subsection 1033.02 of the Standard Specifications. Sampling size and frequency shall adhere to the current Department Materials Sampling Guide.
 - h. Soundness tests shall not be required for fine sand.
 - i. Once the satisfactory quality of aggregates from a source has been established, sufficient additional soundness tests will be performed to insure the continued satisfactory quality of the material, as determined by the Materials Sampling Guide
 - j. Aggregate consensus properties may be performed on material prior to the application of hydrated lime.
 - k. The coarse aggregate angularity value of the blended aggregate material shall meet or exceed the minimum values for the appropriate asphaltic

concrete type as shown in Table 1028.02. If the coarse portion of the blend is all ledge rock the CAA tests may be waived.

**Table 1028.02
Coarse Aggregate Angularity
(ASTM D 5821)**

Asphaltic Concrete Type	CAA (minimum)
SPS	--
SPR	83
SPH	95/90*

* Denotes two faced crushed requirements

- I. The fine aggregate angularity value of the blended aggregate material shall meet or exceed the minimum values for the appropriate asphaltic concrete type as shown in Table 1028.03.
- m. The specific gravity for calculation of the Fine Aggregate Angularity (FAA) shall be determined on a washed combined aggregate sample of the material passing the No. 8 (2.36 mm) sieve and retained on the No. 100 (150 µm) sieve. The Contractor will determine the specific gravity to be used in the calculation of FAA mixture design value(s) and, if verified by the Department Aggregate Laboratory, this same value can be used throughout production. The verification value determined by the Department Aggregate Laboratory will be on a combined aggregate sample supplied by the Contractor that is representative of the material proposed or being used during production. The specific gravity to be used throughout production to calculate FAA values will be the Contractor's verified value or the Department determined value (whenever verification is not made) and will be noted on the Mix Design. Changes in aggregate percentages during production may require determination of a revised specific gravity for FAA.

**Table 1028.03
Fine Aggregate Angularity
(AASHTO T304 Method A)**

Asphaltic Concrete Type	FAA (minimum)
SPS	--
SPR	43.0
SPH	45.0

- n. The coarse aggregate shall not contain flat and elongated particles exceeding the maximum value for the appropriate asphaltic concrete type category shown in these provisions according to Table 1028.04.

**Table 1028.04
Flat and Elongated Particles*
(ASTM D 4791)**

Asphaltic Concrete Type	Percent, Maximum
SPS	25
SPR	10
SPH	10

*Criterion based on a 5:1 maximum to minimum ratio.

- o. The sand equivalent of the blended aggregate material from the fine and coarse aggregates shall meet or exceed the minimum values for the appropriate asphaltic concrete type shown in these provisions according to Table 1028.05.

**Table 1028.05
Sand Equivalent Criteria
(AASHTO T 176)**

Asphaltic Concrete Type	Sand Equivalent, Minimum
SPS	30
SPR	45
SPH	45

- p. Dust to binder ratio is the ratio of the percentage by weight of aggregate finer than the No. 200 (75 µm) sieve to the asphalt content expressed as a percent by weight of total mix. The dust to binder ratio shall be within 0.70 and 1.70.
- q. The blended aggregate shall conform to the gradation requirements specified in Table 1028.06 and Table 1028.07 for the appropriate nominal size.

**Table 1028.06
Gradation Control Points for 0.75 Inch (19 mm) and 0.5 Inch (12.5 mm) Nominal Size**

English Sieve (Metric)	0.75 Inch (19 mm) Control Points (percent passing)		0.5 Inch (12.5 mm) Control Points (percent passing)	
	Minimum	Maximum	Minimum	Maximum
1 inch (25 mm)	100.0			
3/4 inch (19 mm)	90.0	100.0	100.0	
1/2 inch (12.5 mm)		90.0	90.0	100.0
3/8 inch (9.5 mm)				90.0
No. 8 (2.36 mm)	23.0	49.0	28.0	58.0
No. 16 (1.18 mm)				
No. 30 (600 µm)				
No. 50 (300 µm)				
No. 200 (75 µm)	2.0	8.0	2.0	10.0

Table 1028.07
Gradation Control Points for 0.375 Inch (9.5 mm) Nominal Size and SPR

English Sieve (Metric)	0.375 Inch (9.5 mm) Control Points (percent passing)		SPR Control Points (percent passing)		SPR (Fine) Control Points (percent passing)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
3/4 inch (19 mm)			98.0	100.0		
1/2 inch (12.5 mm)	100.0					
3/8 inch (9.5 mm)	90.0	100.0	81.0	89.0	81.0	96.0
No. 4 (4.75 mm)		90.0				
No. 8 (2.36 mm)	32.0	67.0	46.0	56.0	46.0	56.0
No. 16 (1.18 mm)						
No. 30 (600 μm)						
No. 50 (300 μm)			12.0	21.0	12.0	21.0
No. 200 (75 μm)	2.0	10.0	4.0	9.0	4.0	9.0

- r. The combined mineral aggregate for Asphaltic Concrete, Type SPS, shall be an aggregate or a combination of aggregates, and mineral filler if needed, that conforms to the gradation requirements specified in Table 1028.08.

Table 1028.08
Gradation Control Points for Type SPS

English Sieve (Metric)	Control Points (percent passing)	
	Minimum	Maximum
1 inch (25 mm)	100.0	
¾ inch (19 mm)	94.0	100.0
½ inch (12.5 mm)	81.0	100.0
No. 4 (4.75 mm)	70.0	90.0
No. 8 (2.36 mm)	42.0	70.0
No. 16 (1.18 mm)	29.0	43.0
No. 30 (600 μm)	19.0	34.0
No. 50 (300 μm)	11.0	20.0
No. 200 (75 μm)	2.0	10.0

- s. Mineral filler shall consist of pulverized soil, pulverized crushed rock, broken stone, gravel, sand-gravel, sand or a mixture of these materials that conforms to the requirements in Table 1028.09.

**Table 1028.09
 Mineral Filler for Type SPS**

	Min.	Max.
Total Percent Passing the No. 50 (300 μm) Sieve	95	100
Total Percent Passing the No. 200 (75 μm) Sieve	80	100
Plasticity Index (material passing the No. 200 (75 μm) Sieve, except soil)	0	3
Plasticity Index for Soil	0	6

1028.03 -- Acceptance Requirements

1. Mix Criteria:
 - a. The target value for the air voids of the SPH Asphaltic Concrete shall be 4% (±1%) at the Ndes number of gyrations. For Type SPS Asphaltic Concrete the air voids at Ndes shall be a minimum of 1.5% with a maximum of 5.0%. For Type SPR Asphaltic Concrete the air voids shall be 3% (±1%) at the Ndes number of gyrations.
 - b. The design criteria for each mixture shall be determined from Tables 1028.10, 1028.11, and 1028.12.

**Table 1028.10
 Gyratory Compaction Effort
 (Average Design High Air Temperature <39 degrees C)**

Asphaltic Concrete Type	Nini	Ndes	Nmax
SPS	6	40	62
SPR	7	65	100
SPH	8	95	150

**Table 1028.11
 Gyratory Compaction Temperatures**

Mix Type	% RAP	Compaction Temp °F
SPS	0-25	270 ± 5
	26-50	280 ± 5
SPR	0-35	280 ± 5
	36-50	290 ± 5
SPH	0-35	300 ± 5

**Table 1028.12
Minimum Binder Content**

Mix Type (Metric)	Minimum Binder Content, Percent
SPS	4.8
SPR	5.0
3/8 inch (9.5 mm)	5.5
1/2 inch (12.5 mm)	5.1
3/4 inch (19 mm)	5.0

- c. During production of Lot #1 and randomly selected lots thereafter, the Contractor shall provide to the Department 6 properly prepared gyratory samples for AASHTO T 283 testing for all mixtures except Asphaltic Concrete Type SPS. Superpave mixtures shall contain 1.25% hydrated lime as specified in the Special Provision "Hydrated Lime for Asphaltic Mixtures". Each Superpave mixture shall be tested for moisture sensitivity in accordance with AASHTO T 283. The 6 inch (150 mm) specimens shall be compacted in accordance with AASHTO T 312 to 7% ($\pm 0.5\%$) air voids at 95 mm in height and evaluated to determine the Tensile Strength Ratio (TSR).
 - d. During production of Lot #1, the Contractor shall provide to the Department two 75mm gyratory puck samples at 4.0% voids ($\pm 0.5\%$) for APA testing for all mixtures except Asphaltic Concrete Type SPS.
2. The Contractor shall make Mix adjustments when:
 - a. The mix does not meet the current approved JMF or any other requirements of the contract.
 - b. Surface voids create a surface or texture that does not meet the criteria of Sections 502 and 503 in these Standard Specifications.
 - c. Rutting occurs.
 3. The Contractor shall inform the Engineer when changes in mixture properties or materials used occur for any reason. Changes such as, but not limited to, types or sources of aggregates or changes in grades, sources, properties or modification procedures (if modified) of PG Binders. The Department may require a new job mix formula, mix design and moisture sensitivity test. The new proposed job mix formula shall be in accordance with the requirements as stated above.
 4. Mix adjustments at the plant are authorized within the limits shown in Table 1028.13 as follows:
 - a. The adjustment must produce a mix with the percent air voids and all other properties as stated in these specifications.
 - b. All adjustments must be reported to the Engineer.

- c. The adjustment values in Table 1028.13 will be the tolerances allowed for adjustments from the Department verified mix design “Combined Gradation” target values which resulted from production or mix design adjustments, but cannot deviate from Superpave gradation criteria. Mix adjustments for individual aggregates, including RAP, greater than 25% of the original verified mix design proportion or greater than 5% change in the original verified mix design percentage, whichever is greater, may require the Contractor to submit a new mix design, as determined by the Engineer. The Contractor is responsible for requesting new mix design targets as they approach these tolerances, failure to do so may result in a suspension of operations until a new mix design is approved.

Table 1028.13

Aggregate Adjustments	
Sieve Size	Adjustments
1 inch (25 mm), 3/4 inch (19 mm), 1/2 inch (12.5 mm), 3/8 inch (9.5 mm), No. 4 (4.75 mm)	± 6%
No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm)	± 5%
No. 200 (75 µm)	± 2%

5. Sampling and Testing:

- a. The Contractor shall take samples at frequencies identified by the Engineer, according to the Department statistically based procedure. The samples shall be approximately 75 lbs (34 kg) and split according to AASHTO T-248 to create a companion sample. This sample splitting can be either at: 1) the sampling location, with the Department taking custody of their sample at that time or 2) after being transported to the test facility in an insulated container, with the Department taking custody of their sample at that time as determined by the Engineer. The details of sampling, location, splitting etc. shall be determined at the pre-construction conference.
- b. All samples transported to the test facility and companion samples within the Lot shall be identified by attaching or faxing the lab calculation sheet from the latest version of the superpave software, stored, and retained by the Contractor until the Department has completed the verification testing process. Transporting of all samples will be under the observation of Department.
- c. (1) The sample shall be taken from the roadway, behind the paver before compaction or from the windrow. For SPS mixes, the Contractor has the option to obtain the samples directly at the plant.
- (2) At least one QC sample shall be tested for every 750 tons (680 Mg) of plant produced mix.
- (i) If, at the completion of the project, the final lot consists of less than 3,750 tons (3,400 Mg) of asphaltic concrete,

1 sample for each 750 tons (680 Mg) or fraction thereof, shall be taken and tested.

- (3) Additional sampling and testing for the Contractor's information and quality control may be performed at the Contractor's discretion. Any additional testing will not be used in pay factor determination.
- (4) (i) When cold feed samples are being taken, the acquisition shall be timed such that the material in the sample represents, as close as possible, the same material in the sample taken behind the paver. If cold feeds are sampled and tested by Contractor, a split of that sample must be submitted with the hot mix subplot sample. The Contractor will be notified what subplot (a minimum of 1 subplot per lot) sample must be tested for FAA and CAA from the blended cold feed material according to the Department random sampling schedule. All other FAA and CAA subplot samples may be taken from the randomly selected portion of the blended cold feed material or obtained from the random samples taken behind the paver. Samples shall be taken under the observation of Department and split according to AASHTO T-248, with the Department taking custody of their sample at that time.
 - (ii) For projects using RAP material the FAA shall be established as follows: a RAP sample will be processed through an ignition oven and then combined with the proportioned amount of virgin aggregate defined by the mix design and then proceeding with FAA and CAA testing.
- d. The sample shall be compacted immediately while still hot (additional heating may be required to raise the temperature of the sample to compaction temperature).
- e. Each production sample shall be tested as follows:
 - (1) Bulk Specific Gravity (Gmb) shall be determined for each specimen in accordance with AASHTO T 166 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens. One specimen shall be compacted for each production sample.
 - (2) One Theoretical Maximum Specific Gravity (Gmm) test for each production sample of uncompacted mixture shall be determined in accordance with AASTHO T 209 procedure 9.5.1. Weight in water - Maximum Specific Gravity of Bituminous Paving Mixtures.
 - (3) (i) The Blended Aggregate Bulk Specific Gravity (Gsb) shall be 2.585 for information only for all mixes.
 - (ii) FAA - AASHTO T 304 Method A. The pour time of the test sample into the funnel shall be completed in 5±1 seconds.
 - (iii) CAA - ASTM 5821. For SPR mixes, CAA testing and results are only required on the cold feed verification test for the lot.

- (4) The laboratory air voids shall be determined in accordance with the following:

Table 1028.14

$\text{Gmb}(\text{corr})@N_{\text{any}} = \text{Gmb}(\text{meas})@N_{\text{max}} \times (\text{height}@N_{\text{max}} \div \text{height}@N_{\text{any}})$ $\% \text{Gmm}(\text{corr})@N_{\text{any}} = 100 \times (\text{Gmb}(\text{corr})@N_{\text{any}} \div \text{Gmm}(\text{meas}))$ $\% \text{ Air Voids}@N_{\text{any}} = 100 - \% \text{Gmm}(\text{corr})@N_{\text{any}}$ $\text{VMA}@N_{\text{des}} = 100 - (\text{Gmb}(\text{corr})@N_{\text{des}} \times P_s \div G_{\text{sb}})$ $\text{VFA}@N_{\text{des}} = 100 \times ((\text{VMA}@N_{\text{des}} - \% \text{ Air Voids}@N_{\text{des}}) \div \text{VMA}@N_{\text{des}})$ $\text{Measured} = (\text{meas})$ $\text{Corrected} = (\text{corr})$
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- (5) (i) The percent of PG Binder shall be determined for each QC test. The percent of PG Binder will be computed by ignition oven results. A correction factor of 0.3% will be added to the ignition oven results for mixes containing hydrated lime.
- (ii) The gradations shall be determined for each QC test using AASHTO T 30.
- (6) Except as noted in this Subsection, all sampling and testing shall be done as prescribed in the Department Materials Sampling Guide and Standard Method of Tests.
- f. Testing Documentation:
- (1) All test results and calculations shall be recorded and documented on data sheets using the latest version of Department provided "Superpave" software. A copy containing complete project documentation will be provided to the Department at the completion of asphalt production.
- g. Superpave Software:
- (1) QC charts from the software shall be made available for review by the Engineer at any time.
- (2) As a minimum, the following values shall be reported on Department provided software:
- (i) Laboratory Gyratory density.
- (ii) Ignition oven or cold feed aggregate gradations for all Superpave sieves will be reported.
- (iii) PG Binder content shall be plotted to the nearest 0.01% by ignition oven results in accordance with AASHTO T 308.
- (iv) The theoretical maximum specific gravity (Rice) to the nearest 0.001% will be reported.
- (v) Laboratory Gyratory air voids at Ndes shall be plotted to nearest 0.1%. Laboratory Gyratory air voids, at Nini, Ndes and Nmax shall be reported to nearest 0.1%.

- (vi) FAA and CAA of the asphaltic concrete for both cold feed and ignition oven samples will be reported to the nearest 0.1% for FAA and 1% for CAA. A minimum of one subplot FAA and CAA cold feed sample per lot will be tested and recorded on Department provided software.
 - (vii) VMA content shall be plotted to nearest 0.1% and VFA shall be reported to the nearest 0.1%.
 - (viii) Dust to Binder ratio to the nearest 0.01 will be reported.
6. Verification Sampling and Testing:
- a. The Department will select and test at random one of the subplot samples (750 tons, 680 Mg) within a Lot (3750 tons, 3400 Mg) for verification and report results.
 - b. The results of Contractor QC testing will be verified by the Department's verification tests. Any samples outside of the tolerances in Table 1028.15 and 1028.16 will result in an Independent Assurance (IA) review of testing and may result in the Department test results being applied.
 - (1) On any given Lot, if the results of Air Void verification testing and its companion QC testing are within 1.0% air voids, the Air Void verification for the entire Lot is complete and the Contractor test results will be used to determine the pay factors. If the Air Void verification test results and the companion QC test results are outside the above tolerance, the results from the verification test will be used to determine the pay factor for that subplot. Any or all of the remaining four Department subplot samples may be tested and the Department subplot test results may be applied to the respective sublots and the resulting pay factors will apply.
 - (2) On any given Lot, if the results of the FAA verification testing and its companion QC testing are within 0.5 percent, the FAA verification for the entire Lot is complete and the Contractor test results will be used to determine the pay factor. If the FAA verification test results and the companion QC test results are outside the above tolerance, the results from the verification test will be used to determine the pay factor for that subplot. Any or all of the remaining four Department subplot samples may be tested and the Department subplot test results may be applied to the respective sublots and the resulting pay factors will apply.
 - c. When verification tests are within testing tolerance but results show a consistent pattern of deviation from the QC results, the Engineer may cease production and/or request additional verification testing or initiate a complete IA review.

**Table 1028.15
 Asphaltic Concrete Testing Tolerances**

Test	Tolerance
Asphalt Content by Ignition Oven	0.5%
Gyratory Density	0.020
Maximum Specific Gravity	0.015
Bulk Dry Specific Gravity (Gsb)	0.020
FAA	0.5%
CAA	10%
Field Core Density	0.020
Air Voids	1.0%

**Table 1028.16
 Blended Aggregate Gradation
 Testing Tolerances**

Sieve Size	Tolerance
3/4 inch (19 mm), 1/2 inch (12.5 mm), 3/8 inch (9.5 mm), No. 4 (12.5 mm), No. 8 (2.36 mm)	5%
No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm)	4%
No. 200 (75 µm)	2%

- d. Independent Assurance (IA) Review of Testing:
- (1) The Contractor shall allow the Department personnel access to their laboratory to conduct IA review of technician testing procedures and apparatus. Any deficiencies discovered in testing procedures will be reported by the department and corrected by the Contractor.
 - (2) During IA review, the Department personnel and the Contractor will split a sample for the purpose of IA testing. The samples selected will be tested in the Department Branch Laboratory. Any IA test results found to be outside of defined testing tolerances above will be reported. The Contractor shall verify the testing apparatus and make corrections if the apparatus is out of tolerance.
 - (3) See Section 28 of the Materials Sample Guide for more information on IA testing.
- e. If the project personnel and the Contractor cannot reach agreement on the accuracy of the test results, the Department will be asked to resolve the dispute, which will be final. It is the Contractor's responsibility to obtain a large enough sample size for any referee testing (a total sample size of 6000 grams, to be retained by the Department after splitting, is recommended for FAA testing). All dispute resolutions will be in accordance with the Quality Assurance Program requirements in the NDOR Materials Sampling Guide.

7. Production Tolerances, Acceptance, and Pay Factors

**Table 1028.17
 Production Tolerances***

Test	Allowable Deviation from Specification
<i>Dust to Asphalt Ratio</i>	None
<i>Coarse Aggregate Angularity</i>	- 5% below Min.
<i>Fine Aggregate Angularity for SPR Only</i>	- 0.2% below Min. for cold feed - 0.5% below Min. for ignition oven
<i>Fine Aggregate Angularity for all other mixes</i>	- 0.5% below Min. for cold feed - 1.0% below Min. for ignition oven
Minimum Binder Content	None

* These tolerances are applied to the mix design specification values, not the submitted mix design targets.

- a. The Contractor shall notify the Engineer whenever a test result approaches the Specification limits.
- b. When any single test result for FAA testing falls outside the allowable production tolerances in Table 1028.17, the material represented by this test will be accepted with a 20% penalty or rejected, as determined by the Engineer. For all other tests, when any single test result, on the same mix property, from two consecutive QC samples fall outside the allowable production tolerances in Table 1028.17, the material represented by these tests will be accepted with a 20% penalty or rejected, as determined by the Engineer.
- c. The Contractor shall assume the responsibility to cease operations when specifications are not being met.
- d. Acceptance and pay factors for Asphaltic Concrete Type SPS will be based on compacted in place average density and joint density.
- e. For each subplot of Asphaltic Concrete Type SPS, SPR and SPH, the asphaltic concrete unit price is a product of all applicable pay factors for the item "Asphaltic Concrete, Type ____". Included in a subplot, following approval of the control strips, may be any roadway Asphaltic Concrete Type SPS, SPR or SPH which is produced and approved by the Engineer and including material used for Patching, State Maintenance Patching, and Asphalt for Intersections and Driveways on project shall be eligible for inclusion in subplot(s) tonnage pay factor determination using the roadway Asphaltic Concrete Type _____ unit price. When a control strip is not constructed, the pay factor for the running average of four air voids shall be fixed at 1.0 for the first three asphaltic concrete sublots.
 - (1) When there is a production tolerance pay factor penalty as stated in Paragraph 7.b. subsection 1028.03 this penalty percentage will be entered in the Superpave Asphalt Pay Factor Summary under production specifications for each subplot affected. These

individual pay factors will then be multiplied by each other to determine a total pay factor for each subplot [(750 tons) (680 Mg)].

- f. The pay factors for the single test air voids and moving average of four air voids pay factors will be determined in accordance with Table 1028.18.

Table 1028.18
Acceptance Schedule
Air Voids - N_{des}

Air voids test results for Asphaltic Concrete Type SPR	Air voids test results for SPH Asphaltic Concrete	Pay Factor	
		Moving average of four	Single test
Less than 0.5%	Less than 1.5%	50% or Reject	50% or Reject
0.5% to 0.9%	1.5% to 1.9%	50% or Reject	50%
1.0% to 1.4%	2.0% to 2.4%	50% or Reject	95%
1.5% to 1.9%	2.5% to 2.9%	90%	95%
2.0% to 2.4%	3.0% to 3.4%	100%	100%
2.5% to 3.5%	3.5% to 4.5%	102%	104%
3.6% to 4.0%	4.6% to 5.0%	100%	100%
4.1% to 4.5%	5.1% to 5.5%	95%	95%
4.6% to 5.0%	5.6% to 6.0%	90%	95%
5.1% to 5.5%	6.1% to 6.5%	50% or Reject	90%
5.6% to 6.0%	6.6% to 7.0%	50% or Reject	50%
6.1% and over	7.1% and over	50% or Reject	50% or Reject

8. Asphalt Concrete Density Samples:

- a. The Contractor shall perform density tests under direct observation of Department personnel. The Contractor shall establish the method of testing in the preconstruction conference and shall test in accordance with the AASHTO T 166, NDR T 587, or as otherwise described in these Special Provisions. The Contractor shall insure that the proper adjustment bias and/or correction factors are used and accessible to Department personnel along with all other inputs when NDR T 587 is selected. All correlation factors and test results shall be generated and reported on the Department Density spreadsheet. When AASHTO T 166 is being used, the Department will observe the Contractor taking, transporting, and testing the cores. The Department will take immediate custody of the cores at the completion of the testing. All disputed values determined using NDR T 587 will be resolved using AASHTO T 166.
- b. The Contractor shall determine the density of samples by comparing the specific gravity of the core sample to the Maximum Specific Gravity (Rice) as follows:

$$\% \text{ Density} = \frac{\text{Specific Gravity of Core}}{\text{Maximum Mix Specific Gravity Rice}} \times 100$$

where:

$$\text{Sp. Gr. of Core} = \frac{\text{Wt. of Core in Air}}{\text{Wt. of Core in Water}}$$

Wt. of SSD Core – Wt. of Core in Water

Maximum Mix $\frac{\text{Wt. of Mix in Air}}{\text{Wt. of Mix in Air} - \text{Wt. of Mix in Water}}$

Specific Gravity = (Rice)

Note: The individual QC test value of the Maximum Mix Specific Gravity (Rice), determined by AASHTO T 209, will be used to calculate the density of each corresponding core.

- c. The Contractor shall cut cores the first day of work following placement of the mixture. The core samples shall be a minimum of a 3 inch (75mm) diameter.
- d. Normally, 1 sample for determination of density will be taken from each subplot (750 tons) (680 Mg) at locations determined by the Engineer.
- e. The average density of the lot shall be used to compute the pay factor for density. Exceptions to the sampling and testing of core samples for the determination of density are as follows:
 - (1) When the nominal layer thickness is 1 inch (25 mm) or less, the sampling and testing of density for this layer will be waived.
 - (2) When the average thickness of the 5 cores for a lot is 1 inch (25 mm) or less, the testing of density samples for this lot will be waived.
 - (3) When the nominal layer thickness and the average of the original 5 cores for a lot are both more than 1 inch (25 mm), but some of the cores are less than 1 inch (25 mm) thick, additional cores shall be cut at randomly selected locations to provide 5 samples of more than 1 inch (25 mm) thickness for the determination of the pay factor for density.
- f.
 - (1) If, at the completion of the project, the final lot consists of less than 3,750 tons (3400 Mg) of asphaltic concrete, a minimum of 3 samples, or 1 sample for each 750 tons (680 Mg) or fraction thereof, whichever is greater, shall be taken and tested for density.
 - (2) The test results shall be averaged and the density pay factor based on the values shown in Table 1028.19.
 - (3) Should the average of less than 5 density tests indicate a pay factor less than 1.00, additional density samples to complete the set of five shall be taken at randomly selected locations and the density pay factor based on the average of the 5 tests.

Table 1028.19

Acceptance Schedule Density of Compacted Asphaltic Concrete	
Average Density (5 Samples, Percent of Voidless Density)	Pay Factor
Greater than 92.4	1.00
Greater than 91.9 to 92.4	0.95
Greater than 91.4 to 91.9	0.90
Greater than 90.9 to 91.4	0.85
Greater than 90.4 to 90.9	0.80
Greater than 89.9 to 90.4	0.70
89.9 or Less	0.40 or Reject

- g. If requested by the Contractor, check tests for all density tests in the original set, taken no later than the working day following the receipt of all test results for the lot, will be allowed in lots with a density pay factor of less than 1.00. No re-rolling will be allowed in these lots. Locations for checks tests will be provided by the Engineer from the Random Sampling Schedule. The average density obtained by the check tests shall be used to establish the density pay factor for the lot.
- h. The location of density samples are identified by the Random Sampling Schedule. When the random location is noted as zero or the lane width (i.e., zero or 12 ft. on a 12-foot lane), the core shall be cut with the outer edge of the core barrel no greater than 4 inches away (laterally) from the edge of the top of the mat for an unconfined edge or from the edge of the top of the hot mat (joint) for a confined edge. If using a nuclear gauge, the 4 inches would be measured to the edge of the gauge base. The percent density value at these edge-of-lane locations shall be adjusted upward by 2.5%, but to a value of no greater than 92.5%, and the resultant value used in determining the density pay factor. No initial value of 92.5 or greater shall be adjusted.

**WARM MIX ASPHALT
(J-7-1013)**

The Contractor has the option to use Warm Mix Asphalt (WMA) meeting the following requirements.

- 1. Warm Mix Asphalt (WMA)

Warm Mix Asphalt mixtures shall follow the requirements of Superpave Asphaltic Concrete and all other applicable sections with the following exceptions:

- a. The Contractor shall request the use of a WMA additive in writing when submitting the Job Mix Formula. The requested additive shall be an approved Level I or II production product or combination thereof. The manufacturer's

recommended additive rates, specifications, and all other pertinent information shall be included in the requests. All requests must be approved by the Flexible Pavements Engineer prior to their use.

b. Level I Production

- (1) Level I WMA additives are as follows: water injection devices.
- (2) Hydrated Lime at 1.25% by weight of virgin aggregate is required for all mixtures.
- (3) The allowable drop in temperature shall be a maximum of 40°F below the producer's recommended production temperature for Hot Mix Asphalt (HMA), or less as required during production to achieve proper laydown and compaction properties. Plant production temperatures shall not drop below 230°F.

c. Level II Production

- (1) Level II WMA additives are as follows: Advera, Evotherm (DAT, ET, 3G), AkzoNobel Rediset LQ-1102C, and Sasobit.
- (2) For amine based WMA additives, 25% of the additive must be considered an amine based anti-striping agent. Amine based WMA additives with anti-striping agents shall be terminal blended by the binder supplier or a system approved by the Flexible Pavements Engineer for application at the plant. For all other warm mix technologies hydrated lime shall be added at a minimum rate of 1.25% by weight of virgin aggregate, including the weight of limestone. Hydrated Lime shall not be used on Level II WMA mixtures when the WMA additive is an Amine based additive or when the Amine WMA additives are used in combination with Level I water injection. The minimum rate for amine based WMA additives shall be 0.7%. The dosage rate of anti-strip shall not exceed manufacturer's recommendations.
- (3) The drop in temperature shall be a maximum of 90°F from the producer's recommended production temperature for HMA. Plant production temperatures shall not drop below 215°F.

d. Other WMA additives shall not be used unless otherwise approved by the Flexible Pavements Engineer.

e. WMA additives may be used in combination by approval of the Flexible Pavements Engineer.

f. Asphalt mixes shall be tested for TSR on the first lot of production and then on randomly selected lots thereafter.

g. Field samples shall be heated and compacted using the following table unless otherwise approved by the Flexible Pavements Engineer.

Gyratory Compaction Temperatures

Mix Type	% Rap	Compaction Temp °F
SPS	0-25	270 ± 5
	26-50	280 ± 5
SPR	0-35	280 ± 5
	36-50	290 ± 5
SPH	0-35	300 ± 5

- h. NDOR may suspend or eliminate the use of WMA on a project if any of the following conditions occur: rutting, segregation, surface voids, tearing, irregular surface, low density, raveling, stripping, or if pavement does not meet any other design criteria.
- 2. Warm Mix Asphalt (WMA) additives will be measured and paid for directly by the unit of each for the item "Hydrated Lime/Warm Mix Asphalt" for each ton of hot mix asphalt produced.

**ASPHALT DENSITY GAUGE
(J-7-1013)**

Description

An Asphalt Density Gauge may be used for Quality Control when determining the in-place density of asphaltic concrete.

Material Requirements

The device must be approved by the Flexible Pavements Engineer.

Testing Method

1. The Contractor shall establish the method of testing in the preconstruction conference. All testing shall be in accordance with AASHTO T-343 and as directed in this provision.
2. The first 3 density locations of the project shall be cored in accordance with AASHTO T166 to calibrate the asphalt density gauge. Prior to coring, the Contractor shall calibrate the device at each core location.
3. Calibration: A correction factor shall be established for the first 3 cores by calculating the difference between the average density measurement of the asphalt density gauge and the roadway core density. This correction factor shall be entered into the device and used for measuring subsequent densities. The correction factor shall be verified with another core for every 15 density readings that are to be recorded.
4. Density Reading Procedure: Place the asphalt density gauge on the asphalt mat over the area to be tested. Record the density reading, and repeat this process for a total of 5 readings, as detailed in Figure 1. An average of the 5 readings will be used as the density reading for each location. For densities taken less than 6 inches from the edge of the lift, density readings shall be taken as shown in Figure 2. The span between density reading locations in each direction shall be no greater than 12”.

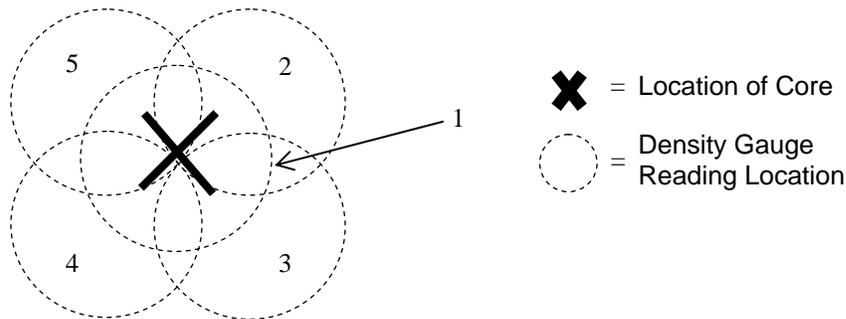


Figure 1: Asphalt density gauge reading pattern

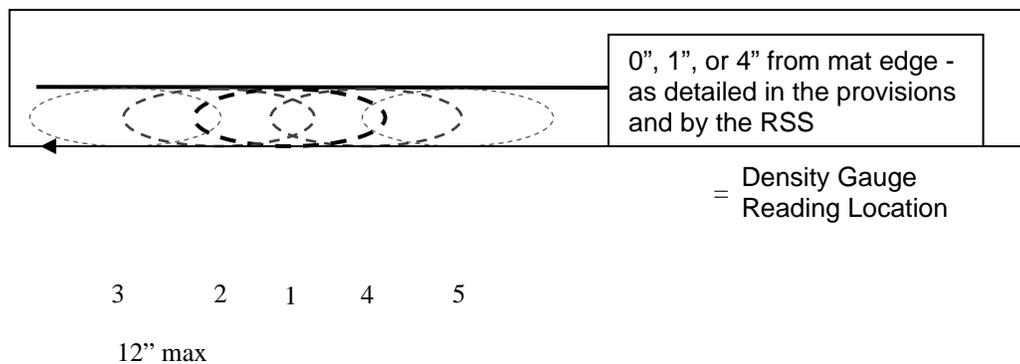


Figure 2: Asphalt density gauge reading pattern less than 6” from mat edge

5. If any density measured by the asphalt density gauge is below 90%, a density core shall be cut at that location and used for density measurement for that subplot. Density readings below 90% shall not be used to calculate a correction factor. All disputed values determined using the asphalt density gauge will be resolved using AASHTO T 166.

ASPHALTIC CONCRETE LONGITUDINAL JOINT DENSITY TESTING (J-7-1013)

Description

One sample for determination of joint density will be taken randomly from each lot. This joint density sample stands independent of the required standard density per subplot used for determining the average of 5 density pay factor.

Equipment

Testing shall be conducted in accordance with the AASHTO T 166, NDR T 587, or an approved Asphalt Density Gauge. The Contractor shall insure that the proper adjustment bias and/or correction factors are used and accessible to Department personnel, along with all other inputs when NDR T 587 or the Asphalt Density Gauge is selected. All correlation factors and test results shall be generated and reported on the Department Density spreadsheets.

Testing

1. The Contractor shall establish the method of testing in the preconstruction conference.
2. One sample for determination of joint density will be taken randomly from each lot, as determined by the Engineer. The location of the edge density samples are identified by the Random Sampling Schedule.
3. The joint density core shall be cut 1 inch away (laterally) from the identified edge of the top of the mat.
4. The Contractor shall cut cores the first day of work following placement of the mixture. The core samples shall be a minimum of a 3 inch (75mm) diameter.
5. The Department will observe the Contractor taking, transporting, and testing the cores (as applicable). The Department will take immediate custody of the cores at the completion of the testing. All disputed values determined using NDR T 587 or the Asphalt Density Gauge will be resolved using AASHTO T166.

6. The Contractor shall determine the density of samples by comparing the specific gravity of the core sample to the Maximum Specific Gravity (Rice) as follows:

$$\% \text{ Density} = \frac{\text{Specific Gravity of Core}}{\text{Maximum Mix Specific Gravity Rice}} \times 100$$

where:

$$\text{Sp. Gr. of Core} = \frac{\text{Wt. of Core in Air}}{\text{Wt. of SSD Core} - \text{Wt. of Core in Water}}$$

$$\text{Maximum Mix Specific Gravity (Rice)} = \frac{\text{Wt. of Mix in Air}}{\text{Wt. of Mix in Air} - \text{Wt. of Mix in Water}}$$

Note: The individual QC test value of the Maximum Mix Specific Gravity (Rice), determined by AASHTO T 209, will be used to calculate the density of each corresponding core.

7. Exceptions to the sampling and testing of joint density core samples for the determination of density are as follows:
- a. When the nominal layer thickness is 1 inch (25 mm) or less, the sampling and testing of density for this layer will be waived.
 - b. When the average thickness for the standard lot is 1 inch (25 mm) or less, the testing of joint density samples for this lot will be waived.
8. If requested by the Contractor, a re-test for the original joint density test, taken no later than the working day following the receipt of the test result, will be allowed. Locations of re-tests will be provided by the Engineer from the Random Sampling Schedule. The density obtained by the re-test shall be used to establish the density pay factor for the lot.

Method of Measurement

All work related to the Asphaltic Concrete Longitudinal Joint Density Sample will not be measured and paid for but will be subsidiary to the associated asphaltic concrete.

Basis of Payment

1. The pay factor shall be computed according to the following table:

Joint Density Test Lot Pay Factor			
Joint Density	SPS	SPR	SPH
93.0 or greater	102%	102%	102%
92.0 to 92.9	100%	102%	102%
91.0 to 91.9	98%	100%	102%
90.0 to 90.9	98%	98%	100%
89.0 to 89.9	98%	98%	98%
88.9 or Less	98%	98%	98%

2. The pay factor will be incorporated in the production specs calculation in the Superpave Software. Any incentive or disincentive will be added or subtracted to the pay factor after any other applicable production tolerances pay factors have been incorporated. The pay factor will apply to the entire lot.