

SECTION 460 HOT MIX ASPHALT PAVEMENT

460.1 Description

- (1) This section describes HMA mixture design, providing and maintaining a quality management program for HMA mixtures, and constructing HMA pavement.

460.2 Materials

460.2.1 General

- (1) Furnish a homogeneous mixture of coarse aggregate, fine aggregate, mineral filler if required, SMA stabilizer if required, and asphaltic material.

460.2.2 Aggregates

460.2.2.1 General.

- (1) Provide coarse aggregates from a department-approved source as specified under 106.3.4.2. Obtain the engineer's approval of the aggregates before producing HMA mixtures.
- (2) Furnish an aggregate blend consisting of hard durable particles containing no more than a combined total of one percent, by weight, of lumps of clay, loam, shale, soft particles, organic matter, adherent coatings, and other deleterious material. Ensure that the aggregate blend conforms to the percent fractured faces and flat & elongated requirements of table 460-2. If the aggregate blend contains materials from different deposits or sources, ensure that material from each deposit or source has a LA wear percent loss meeting the requirements of table 460-2.

460.2.2.2 Freeze-Thaw Soundness

- (1) If the aggregate blend contains materials from different deposits or sources, ensure that material from each deposit or source has a freeze-thaw loss percentage meeting the requirements of table 460-2.

460.2.2.3 Aggregate Gradation Master Range

- (1) Ensure that the aggregate blend, including RAP and mineral filler, conforms to the gradation requirements in table 460-1. The values listed are design limits; production values may exceed those limits.

TABLE 460-1 AGGREGATE GRADATION MASTER RANGE AND VMA REQUIREMENTS

SIEVE SIZE	PERCENTS PASSING DESIGNATED SIEVES						
	NOMINAL SIZE						
	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	SMA 12.5 mm	SMA 9.5 mm
50.0 mm	100						
37.5 mm	90 – 100	100					
25.0 mm	90 max	90 -100	100				
19.0 mm	___	90 max	90 -100	100		100	
12.5 mm	___	___	90 max	90 -100	100	90 - 97	100
9.5 mm	___	___	___	90 max	90 -100	58 - 72	90 - 100
4.75 mm	___	___	___	___	90 max	25 - 35	35 - 45
2.36 mm	15 – 41	19 - 45	23 - 49	28 - 58	20 - 65	15 - 25	18 - 28
75 µm	0 – 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	8.0 - 12.0	10.0 - 14.0
PERCENT MINIMUM VMA	11.0	12.0	13.0	14.0	15.0	16.0	17.0

- (2) Unless the contract designates otherwise, ensure that the nominal size of the aggregate used in the mixture conforms to the following:

PAVEMENT LAYER	NOMINAL SIZE
Lower layer pavement	19.0 mm
Upper layer pavement	12.5 mm
Stone matrix layer pavement	12.5 mm

460.2.3 Asphaltic Binders

- (1) The department will designate the grade of asphaltic binder in the contract. The contractor may use virgin binder, modified binder, a blend of virgin and recovered binder, or a blend of modified and recovered binder. Ensure that the resultant asphaltic binder conforms to the contract specifications.

460.2.4 Additives

460.2.4.1 Hydrated Lime Antistripping Agent

- (1) If used in HMA mixtures, furnish hydrated lime conforming to ASTM C 977 and containing no more than 8 percent unhydrated oxides. Add one percent or more, by weight of the total dry aggregate. Do not begin production until the engineer approves the lime introduction and mixing methods.

460.2.4.2 Liquid Antistripping Agent

- (1) If used in HMA mixtures, add liquid antistripping agent to the asphaltic binder before introducing the binder into the mixture. Ensure that addition of liquid antistripping agent does not alter the characteristics of the original asphaltic binder beyond the following limits:
 1. A viscosity change of more than +/-400 poises.
 2. A penetration change of more than -4 or +10.

460.2.4.3 Stone Matrix Asphalt Stabilizer

- (1) Add an organic fiber, an inorganic fiber, a polymer-plastic, a polymer-elastomer, or approved alternate stabilizer to all SMA mixtures. If proposing an alternate, submit the proposed additive system, asphaltic binder and stabilizer additive, along with samples of the other mixture materials to the department at least 14 days before the project let date. The department will approve or reject that proposed alternate additive system no later than 48 hours before the project let date.
- (2) Use a single additive system for all SMA pavement in the contract.

460.2.5 Reclaimed Asphaltic Pavement Materials

- (1) The contractor may use up to 35 percent RAP material in lower layer and base mixtures and up to 20 percent in upper layer mixtures. Ensure that the combined RAP and virgin aggregate conforms to aggregate requirements of table 460-2.

460.2.6 Recovered Asphaltic Binders

- (1) Establish the percent of recovered asphaltic binder from RAP for the mixture design according to AASHTO T 164 using the appropriate dust correction procedure. If test results indicate a change in the percent of recovered asphaltic binder from RAP, the contractor or the engineer may request a change in the design recovered asphaltic binder from RAP. Accompany that request with at least 2 recent RAP extractions from the contractor's mixture design laboratory supporting that change.
- (2) The contractor may use up to 25 percent RAP for lower layers and up to 20 percent RAP for upper layers without changing the asphaltic binder grade. If using more than that amount of RAP, furnish binder with a low temperature rating one grade lower than the contract designates, unless testing indicates the resultant binder meets the grade the contract originally specified.

460.2.7 HMA Mixture Design

- (1) For each HMA mixture type used under the contract, develop and submit an asphaltic mixture design according to the department's test method number 1559 and conforming to the requirements of table 460-1 and table 460-2. The values listed are design limits; production values may exceed those limits. The department will review mixture designs and report the results of that review to the designer according to the department's test method number 1559.

TABLE 460-2 MIXTURE REQUIREMENTS

Mixture type	E - 0.3	E - 1	E - 3	E - 10	E - 30	E - 30x	SMA
ESALs x 10 ⁶ (20 yr design life)	< 0.3	0.3 - < 1	1 - < 3	3 - < 10	10 - < 30	≥ 30	—
LA Wear (AASHTO T 96)							
100 revolutions(max % loss)	13	13	13	13	13	13	13
500 revolutions(max % loss)	50	50	45	45	45	45	45
Soundness (AASHTO T 104) (sodium sulfate, max % loss)	12	12	12	12	12	12	12
Freeze/Thaw (AASHTO T 103) (specified counties, max % loss)	18	18	18	18	18	18	18
Fractured Faces (ASTM 5821) (one face/2 face, % by count)	60 / —	65 / —	75 / 60	85 / 80	98 / 90	100/100	100/90
Flat and Elongated (ASTM D4791) (max %, by weight)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	20 (3:1ratio)
Fine Aggregate Angularity (AASHTO T304, method A, min)	40	40	43	45	45	45	45
Sand Equivalency (AASHTO T 176, min)	40	40	40	45	45	50	50
Gyratory Compaction							
Gyrations for N _{ini}	6	7	7	8	8	9	8
Gyrations for N _{des}	40	60	75	100	100	125	65
Gyrations for N _{max}	60	75	115	160	160	205	160
Air Voids, %V _a (%G _{mm} @ N _{des})	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)
% G _{mm} @ N _{ini}	≤ 91.5 ^[1]	≤ 90.5 ^[1]	≤ 89.0 ^[1]	≤ 89.0	≤ 89.0	≤ 89.0	—
% G _{mm} @ N _{max}	≤ 98.0	≤ 98.0	≤ 98.0	≤ 98.0	≤ 98.0	≤ 98.0	—
Dust to Binder Ratio ^[2] (% passing 0.075/P _{be})	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	1.2 - 2.0
Voids filled with Binder (VFB or VFA, %)	70 - 80 [4] [5]	65 - 78 [4]	65 - 75 [4]	65 - 75 [3] [4]	65 - 75 [3] [4]	65 - 75 [3] [4]	70 - 80
Tensile Strength Ratio (TSR) (ASTM 4867)							
no antistripping additive	0.70	0.70	0.70	0.70	0.70	0.70	0.70
with antistripping additive	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Draindown at Production Temperature (%)	—	—	—	—	—	—	0.30

^[1] The percent maximum density at initial compaction is only a guideline.

^[2] For a gradation that passes below the boundaries of the caution zone(ref. AASHTO MP3), the dust to binder ratio limits are 0.6 - 1.6.

^[3] For 9.5mm nominal maximum size mixtures, the specified VFB range is 73 - 76%.

^[4] For 37.5mm nominal maximum size mixes, the specified VFB lower limit is 67%.

^[5] For 25.0mm nominal maximum size mixes, the specified VFB lower limit is 67%.

460.2.8 Quality Management Program

460.2.8.1 General

- (1) Provide and maintain a QC program defined as all activities, including mix design, process control inspection, sampling and testing, and process adjustments related to producing and placing HMA pavement conforming to the specifications. The contractor may also provide an optional CA program.
- (2) The department will provide product quality verification as follows:
 1. By conducting verification testing of independent samples.
 2. By periodically observing contractor sampling and testing.
 3. By monitoring required control charts exhibiting test results and control parameters.
 4. By the engineer directing the contractor to take additional samples at any time during production.
- (3) Refer to CMM 4-15-52 for detailed guidance on sampling, testing, and documentation under the QMP.

460.2.8.2 Contractor Testing

460.2.8.2.1 Required Quality Control Program

460.2.8.2.1.1 Personnel Requirements

- (1) Provide HTCP certified sampling and testing personnel. Provide at least one full-time HMA technician certified at level I or higher at each plant site furnishing material to the project. Before mixture production begins, post an organizational chart in the contractor's laboratory. Include the names, telephone numbers, and current certifications of all personnel with QC or CA responsibilities. Keep the chart updated.
- (2) Ensure that sampling personnel are qualified as follows^[1]:
 - HMA technician certified at level I or higher.
 - HMA ACT.

^[1] After informing the engineer, an uncertified person under the direct observation of an HMA technician certified at level I or higher may sample for a period not to exceed 3 calendar days.

- (3) Ensure that all testing, data analysis, and data posting personnel are qualified as follows:
 - HMA technician certified at level I or higher.
 - HMA ACT under the direct supervision of an HMA technician certified at level I or higher.
- (4) Have an HMA technician certified at level II or higher available to make necessary process adjustments.

460.2.8.2.1.2 Laboratory Requirements

- (1) Conduct QC testing in a facility conforming to the department's laboratory qualification program.
- (2) Ensure that the laboratory has at least 320 square feet (30 m²) of workspace and has a telephone for exclusive use by QMP personnel. Also provide a fax machine and copy machine that the contractor or the engineer can use at the plant site. Ensure that all testing equipment conforms to the equipment specifications applicable to the required testing methods.

460.2.8.2.1.3 Required Sampling and Testing

460.2.8.2.1.3.1 Contracts with 5000 Tons of Mixture or Greater

- (1) Furnish and maintain a laboratory at the plant site fully equipped for performing contractor QC testing. Have the laboratory on-site and operational before beginning mixture production.
- (2) Obtain random samples and perform tests conforming to CMM 4-15-52. Obtain HMA mixture samples from trucks at the plant. Perform tests the same day taking the sample.
- (3) Retain the split portion of the contractor HMA mixture and blended aggregate samples for 14 calendar days at the laboratory site in a dry, protected area. The engineer may decrease this 14-day retention period. At project completion the contractor may dispose of remaining samples if the engineer approves.
- (4) Use the test methods identified below, or other methods the engineer approves, to perform the following tests at a frequency greater than or equal to that indicated:

Blended aggregate according to AASHTO T11 and T27:

Drum plants:

- Field extraction by department test method number 1560.

- Belt samples, optional for virgin mixtures, obtained from stopped belt or from the belt discharge using an engineer-approved sampling device.

Batch plants:

- Field extraction by department test method number 1560.

Asphalt content (AC) in percent:

AC by calculation.

AC by nuclear gauge reading, optional.

AC by inventory, optional.

Bulk specific gravity of the compacted mixture according to AASHTO T166.

Maximum specific gravity according to AASHTO T 209.

Air voids (Va) by calculation according to AASHTO T 269.

VMA by calculation according to AASHTO PP 28.

- (5) Test each design mixture at a frequency at or above the following:

TOTAL DAILY PLANT PRODUCTION FOR DEPARTMENT CONTRACTS in tons (Mg)	SAMPLES PER DAY ^[1]
50 to 600 (45-550)	1
601 to 1500 (551 – 1360)	2
1501 to 2700 (1361 – 2450)	3
2701 to 4200 (2451 – 3810)	4
greater than 4200 (3810)	see footnote ^[2]

^[1] Frequencies are for planned production. If production is less than planned, base the number of samples on actual production. If production is more than planned, continue sampling using that day's previously established increment. Conform to CMM 4-15-52.

^[2] Add a sample for each additional 1500 tons (1360 Mg) or fraction of 1500 tons (1360 Mg).

- (6) Also conduct the following tests on the first day of production and once for every eight production samples thereafter, with a minimum of one test per production week.
- Aggregate stockpile gradations sampled from cold feed bins or stockpile according to AASHTO T 11 and T 27.
 - Reclaimed or salvaged asphaltic pavement extractions sampled from the cold feed bin or stockpile according to AASHTO T 164 and T 30. The contractor may optionally perform a field extraction according to department test method number 1560.
- (7) The department will waive stockpile testing of the aggregate and reclaimed or salvaged asphaltic pavement if the contractor provides data from tests conducted during stockpile production. Ensure that testing and documentation conforms to CMM 4-15-52.
- (8) Also conduct field tensile strength ratio tests according to ASTM D 4867 on all mixtures containing an antistripping additive. Test each full 50,000 ton (46 000 Mg) production increment, or fraction of an increment, in the first week of production of that increment. If field tensile strength ratio values are either below the specification limit or less than the mixture design value by 20 or more, notify the engineer. The engineer and contractor will jointly determine a corrective action.

460.2.8.2.1.3.2 Contracts with Less Than 5000 Tons of Mixture

- (1) Conform to 460.2.8.2.1.3.1 modified as follows:
- The contractor may conduct QC tests in an off-site laboratory.
 - No field tensile strength ratio testing is required.

460.2.8.2.1.3.3 Contracts with Less Than 500 Tons of Mixture

- (1) The engineer may waive all testing on contracts with less than 500 tons (460 Mg) of mixture.

460.2.8.2.1.3.4 Temporary Pavements

- (1) The engineer may waive all testing for temporary pavements, defined as pavements that will be placed and removed before contract completion.

460.2.8.2.1.4 Documentation

460.2.8.2.1.4.1 Records

- (1) Document all observations, inspection records, mixture adjustments, and test results daily. Note observations and inspection records in a permanent field record as they occur. Indicate all process adjustments and JMF changes on the air void control chart. Submit copies of the running average calculation sheet for blended aggregate, mixture, and asphalt content along with the air void chart and adjustment records to the engineer each day. Submit original testing records and control charts to the engineer in a neat and orderly manner within 10 days after paving is completed.
- (2) Continue charts, records, and testing frequencies, for a mixture produced at one plant site, from contract to contract.

460.2.8.2.1.4.2 Control Charts

- (1) Maintain standardized control charts at the laboratory. Record contractor test results on the charts the same day as testing. Post CA test results on the charts as data becomes available. Record data on the standardized control charts as follows:
 - Blended aggregate gradation tests in percent passing. Of the following, plot those sieves the design specifications require: 37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, 9.5 mm, 2.36 mm, and 75 µm.
 - Asphalt material content in percent.
 - Bulk specific gravity of the compacted mixture.
 - Maximum specific gravity of the mixture.
 - Air voids in percent.
 - VMA in percent.
- (2) Plot both the individual test point and the running average of the last 4 data points on each chart. Show QC data in black with the running average in red and CA data in blue. Draw the warning limits with a dashed green line and the JMF limits with a dashed red line. The contractor may use computer generated black-and-white printouts with a legend that clearly identifies the specified color coded components.

460.2.8.2.1.5 Control Limits

- (1) Conform to the following control limits for the JMF and warning limits based on a running average of the last 4 data points:

ITEM	JMF LIMITS	WARNING LIMITS
Percent passing given sieve:		
37.5 mm	+/- 6.0	+/- 4.5
25.0 mm	+/- 6.0	+/- 4.5
19.0 mm	+/- 5.5	+/- 4.0
12.5 mm	+/- 5.5	+/- 4.0
9.5 mm	+/- 5.5	+/- 4.0
2.36 mm	+/- 5.0	+/- 4.0
75 µm	+/- 2.0	+/- 1.5
Asphaltic content in percent	+/- 0.4	+/- 0.3
Air voids in percent	+/- 1.3	+/- 1.0
VMA in percent	- 1.5	- 1.2

- (2) Warning bands are defined as the area between the JMF limits and the warning limits.

460.2.8.2.1.6 Job Mix Formula Adjustment

- (1) The contractor may request adjustment of the JMF according to the department's test method number 1559. Have an HMA technician certified at level II submit a written JMF adjustment request. Ensure that the resulting JMF is within specified master gradation bands. The department will have an HMA technician certified at level III review the proposed adjustment and, if acceptable, issue a revised JMF. The department will not allow adjustments exceeding specified JMF tolerance limits. Have an HMA technician certified at level II make related process adjustments.

- (2) If mixture redesign is necessary, submit a new JMF, subject to the same specification requirements as the original JMF. Do not reduce the JMF asphalt content unless the production VMA meets or exceeds the minimum VMA design requirement for the mixture produced.

460.2.8.2.1.7 Corrective Action

- (1) When running average values trend toward the warning limits, consider taking corrective action. Document all corrective actions undertaken. Include all test results in the contract files and in running average calculations.
- (2) Notify the engineer if running average values exceed the warning limits. If two consecutive running average values exceed the warning limits, stop production and make adjustments. Do not restart production until after notifying the engineer of the adjustments made. Do not calculate a new running average until the fourth test after the required production stop.
- (3) If the process adjustment improves the property in question so that the running average after 4 additional tests is within the warning limits, the contractor may continue production with no reduction in payment.
- (4) If the adjustment does not improve the properties and the running average after 4 additional tests stays inside the warning bands, the mixture is nonconforming and subject to pay adjustment.
- (5) If the contractor fails to stop production and make adjustments when required, all mixture produced from the stop point to the point when the running average is back inside the warning limits is nonconforming and subject to pay adjustment.
- (6) The department will reduce payment for nonconforming QMP HMA mixtures, starting from the stop point to the point when the running average is back inside the warning limits, as follows:

PAYMENT FOR MIXTURE^[1]

ITEM	PRODUCED WITHIN	PRODUCED OUTSIDE
	WARNING BANDS	JMF LIMITS
Gradation	90%	75%
Asphalt Content	85%	75%
Air Voids	70%	50%
VMA	90%	75%

^[1] Payment is in percent of the contract unit price for both the HMA Pavement and Asphaltic Material bid items. The department will reduce pay based on the nonconforming property with lowest percent pay. The asphaltic material quantity is based on the JMF asphalt content. The department will administer pay reduction under the Nonconforming QMP Asphaltic Material and the Nonconforming QMP HMA Mixture administrative items.

- (7) If the running average values exceed the JMF limits, stop production and make adjustments. Do not restart production until after notifying the engineer of the adjustments made. Continue calculating the running average after the production stop.
- (8) If the air voids running average of 4 exceeds the JMF limits, the material is nonconforming. Remove and replace unacceptable material at no additional expense to the department. The engineer will determine the quantity of material to replace based on the testing data using the methods in CMM 4-15-52 and an inspection of the completed pavement. If the engineer allows the mixture to remain in place, the department will pay for the mixture and asphaltic material at 50 percent of the contract price.
- (9) If the running average of 4 exceeds the JMF limits for other properties, the department will pay 75 percent of the contract price for mixture and asphaltic material if the engineer allows the mixture to remain in place. The engineer will determine the quantity of material subject to pay reduction based on the testing data and an inspection of the completed pavement.
- (10) The department may also apply pay adjustments, as specified in 460.2.8.2.1.7(6) through (9), for special circumstances as follows:
 - 1. For plants where the total season production of a mixture requires less than 4 tests, the department will assess the material by comparing single data points to 1.5 times the warning and JMF limits.
 - 2. At contract completion, the department will assess the material by evaluating the last 3 tests as single tests and comparing to 1.5 times the warning and JMF limits.
 - 3. If the contractor's test results prove incorrect.

460.2.8.2.2 Optional Contractor Assurance

460.2.8.2.2.1 General

- (1) CA testing is optional and is conducted to further validate production testing. The contractor may offer CA data to provide an additional piece of information for the following:
 1. Process control decisions.
 2. Troubleshooting possible sampling, splitting, or equipment problems.
 3. Limiting liability, as defined in CMM 4-15-52, for nonconforming product as a result of department verification testing. These provisions do not supercede department's rights under 107.16.

460.2.8.2.2.2 Personnel Requirements

- (1) Ensure that an HMA technician certified under HTCP at level I or higher performs all CA testing and data analysis. Personnel performing CA testing can not perform QC testing for the same materials.

460.2.8.2.2.3 Laboratory Requirements

- (1) Conduct CA testing in a facility conforming to the department's laboratory qualification program. Furnish and maintain a laboratory fully equipped for performing selected CA tests. If the a single laboratory is providing CA and QC data for the same materials, ensure that a separate set of equipment is used to prepare CA samples and run CA tests.

460.2.8.2.2.4 Testing

- (1) For the CA program, use the test methods enumerated here in 460.2.8.2.2.4, other engineer-approved methods, or other methods the industry and department HMA technical team recognizes. The contractor may select tests at its option. If using tests in limiting liability, as provided in CMM 4-15-52, data must exist for the property in question.
- (2) Perform selected testing as follows:
 - Bulk specific gravity (Gmb) of the compacted mixture according to AASHTO T 166 based on the average of 2 specimens.
 - Maximum specific gravity (Gmm) according to AASHTO T 209.
 - Air voids (Va) by calculation according to AASHTO T 269.
 - VMA by calculation according to AASHTO PP 28.
 - Stockpile gradation according to AASHTO T 11 and T 27^[1].
 - Blended aggregate gradation on plant mix according to department test method number 1560.
 - Fine aggregate angularity (FAA) according to AASHTO T 304, method A.

^[1] As modified in CMM 4.

- (3) There is no specified frequency for CA testing.
- (4) The department will compare CA samples to QC samples. Obtain CA samples by retaining a QC split portion conforming to the "rule of retained" requirements, as provided in CMM 4-15-52. Alternatively the contractor may have CA personnel take an additional sample during production. If taking an additional sample, the contractor may, with the engineer's approval, replace one of the required random QC tests for that day with the CA sample.

460.2.8.2.2.5 Documentation

- (1) Report CA test results to the engineer and the contractor's field staff within 2 business days after receiving the samples.

460.2.8.2.2.6 Allowable Differences

- (1) Differences between the QC and CA split sample test results are acceptable in limiting liability, as provided in CMM 4-15-52, if within the following limits:

ITEM	ALLOWABLE DIFFERENCES
Percent passing 12.5 mm sieve	6.0
Percent passing 9.5 mm sieve	6.0
Percent passing 4.75 mm sieve	5.0
Percent passing 2.36 mm sieve	4.0
Percent passing 600 µm sieve	3.5

Percent passing 75 µm sieve	2.0
Bulk specific gravity of the compacted mixture	0.030
Maximum specific gravity	0.020

460.2.8.3 Department Testing

460.2.8.3.1 Quality Verification Program

460.2.8.3.1.1 General

- (1) The engineer will conduct QV tests to determine the quality of the final product and measure characteristics that predict relative performance.

460.2.8.3.1.2 Personnel Requirements

- (1) The department will provide at least one HMA technician, certified under HTCP at level I or higher, to observe QV sampling of project mixtures. An HMA technician certified at level I or higher, or an HMA ACT under the direct supervision of an HMA technician certified at level I or higher, will split, test, analyze data, and post data. The department will make an organizational chart available at the testing laboratory and to the contractor before mixture production begins. The department's chart will include names, telephone numbers, and current certifications of all QV testing personnel. The department will update the chart with appropriate changes, as they become effective.

460.2.8.3.1.3 Laboratory Requirements

- (1) The department will furnish and maintain a facility for QV testing conforming to the department's laboratory qualification program requirements and fully equipped to perform QV testing. In all cases, the department will conduct testing in a separate laboratory from the contractor's laboratory.

460.2.8.3.1.4 Department Verification Testing Requirements

- (1) HTCP certified department personnel will obtain random samples by directly supervising HTCP certified contractor personnel sampling from trucks at the plant. The department will sample conforming to CMM 4-15-52. Sample size must be adequate to run the appropriate required tests in addition to one set of duplicate tests that may be required for dispute resolution. The engineer will split the sample for testing and retain the remaining portion for additional testing if needed.
- (2) The department will verify product quality using the test methods enumerated here in 460.2.8.3.1.4(2), other engineer-approved methods, or other methods the industry and department HMA technical team recognizes. The department will identify test methods before construction starts and use only those methods during production of that material unless the engineer and contractor mutually agree otherwise.
- (3) The department will perform all testing conforming to the following standards:
 - Bulk specific gravity (Gmb) of the compacted mixture according to AASHTO T 166.
 - Maximum specific gravity (Gmm) according to AASHTO T 209.
 - Air voids (Va) by calculation according to AASHTO T 269.
 - VMA by calculation according to AASHTO PP 28.
- (4) The department will test each design mixture at the following minimum frequency:

FOR TONNAGES TOTALING:	
Less than 501 tons (455 Mg)	no tests required
From 501 (455 Mg) to 30,000 tons(27 215 Mg)	one test
More than 30,000 tons (27 215 Mg).....	add one test for each additional 30,000-ton (27 215 Mg) increment

460.2.8.3.1.5 Documentation

- (1) The engineer will document all observations during QV sampling, and review QC mixture adjustments and QC/CA test results daily. The engineer will note results of observations and inspection records in a permanent field record as they occur.

460.2.8.3.1.6 Acceptable Verification Parameters

- (1) The engineer will provide test results to the contractor within 2 mixture-production days after obtaining the sample. The quality of the product is acceptably verified if it meets the following limits:
 - Va is within a range of 2.7 to 5.3 percent.

- VMA is within minus 1.5 of the minimum requirement for the mix design nominal maximum aggregate size.
- (2) If QV test results are outside the specified limits, the engineer will investigate immediately through dispute resolution procedures. The engineer may stop production while the investigation is in progress if the potential for a pavement failure is present.
- (3) If production continues, the engineer will provide additional CA testing at the frequency provided for in CMM 4-15-52. This supplemental testing will continue until the material meets the acceptable limits or as the engineer and contractor mutually agree.

460.2.8.3.1.7 Dispute Resolution

- (1) When QV test results do not meet the specified limits, the bureau's AASHTO accredited laboratory and certified personnel will referee test the retained portion of the QV sample and the retained portion of the nearest available previous QC sample.
- (2) The department will notify the contractor of the referee test results within 2 business days after receipt of the samples.
- (3) The department will determine mixture conformance and acceptability by analyzing referee test results, reviewing mixture project data, and inspecting the completed pavement all conforming to CMM 4-15-52.

460.2.8.3.1.8 Corrective Action

- (1) Remove and replace unacceptable material at no additional expense to the department.
- (2) The department will reduce pay for the tonnage of nonconforming mixture, as determined during QV dispute resolution, if the engineer allows that mixture to remain in place. If production continued during the investigation, the department will also adjust pay for that mixture forward to the next conforming QV or QC/CA point. The department will pay for the affected mixture at 50 percent of the contract price. The department will adjust pay for both the mixture and the asphaltic material.

460.2.8.3.2 Independent Assurance Testing

- (1) The department will evaluate both the contractor and department testing personnel and equipment as specified in 106.3.4.3.6.

460.3 Construction

460.3.1 General

- (1) Construct HMA pavement conforming to the general provisions of 450.3.

460.3.2 Thickness

- (1) Provide the plan thickness for lower and upper layers limited as follows:

NOMINAL SIZE	MINIMUM LAYER THICKNESS in inches (mm)	MAXIMUM LOWER LAYER THICKNESS in inches (mm)	MAXIMUM UPPER LAYER THICKNESS in inches (mm)
37.5 mm	3.5 (89)	5 (127)	4.5 (114)
25.0 mm	3.25 (83)	5 (127)	4 (102)
19.0 mm	2.25 (57)	4 (102)	3 (76)
12.5 mm ^[1]	1.75 (44)	3 (76) ^[2]	2.5 (64)
9.5 mm ^[1]	1.5 (38)	3 (76) ^[2]	2 (51)

^[1] SMA mixtures use nominal size 12.5 mm or 9.5 mm.

^[2] SMA mixtures with nominal sizes of 12.5 mm and 9.5 mm have no maximum lower layer thickness specified.

460.3.3 HMA Pavement Density Maximum Density Method

460.3.3.1 Minimum Required Density

- (1) Compact all layers of HMA mixture to the density table 460-3 shows for the applicable mixture, location, and layer.

TABLE 460-3 MINIMUM REQUIRED DENSITY^[1]

LOCATION	LAYER	PERCENT OF TARGET MAXIMUM DENSITY		
		MIXTURE TYPE		
		E-0.3, E-1, and E-3	E-10, E-30, and E-30x	SMA
TRAFFIC LANES ^[2]	LOWER	91.5 ^[3]	92.0 ^[3]	94.0
	UPPER	91.5	92.0	94.0
SIDE ROADS, CROSSOVERS, TURN LANES, AND RAMPS	LOWER	91.5 ^[3]	92.0 ^[3]	94.0
	UPPER	91.5	92.0	94.0
SHOULDERS AND APPURTENANCES	LOWER	89.5	89.5	91.0
	UPPER	90.5	90.5	91.0

^[1] The table values are for average lot density. If any individual density test result falls below 87% of the target maximum density, the engineer may investigate the acceptability of that material.

^[2] Includes parking lanes as determined by the engineer.

^[3] Minimum reduced by 2 percent for < 3 million ESALs and one percent for > 3 million ESALs, for that lower layer constructed directly on crushed aggregate or recycled base courses.

460.3.3.2 Pavement Density Determination

- (1) The engineer will determine the target maximum density using department procedures. The engineer will measure pavement density for either nuclear density or the density of sawed or cored samples. The engineer and contractor will decide which method to use before paving. A change to the method requires agreement between the engineer, contractor, and the department's quality management section. The engineer will determine density as soon as it is practical after compaction and before placement of subsequent layers. Cut pavement samples as the engineer directs and restore the surface with new, well compacted mixture.
- (2) Do not re-roll compacted mixtures with deficient density test results. Do not operate continuously below the specified minimum density. Stop production, identify the source of the problem, and make corrections to produce work meeting the specification requirements.
- (3) A lot represents 750 tons (680 Mg) of a mixture placed within a single layer for each location and target maximum density category indicated in table 460-3.
- (4) For nuclear density, the department will test 5 random samples on each lot. A nuclear density technician certified at level I will perform the testing. For the density of sawed or cored samples, the department will test 3 random samples, each at least 28 square inches (18 000 mm²) in area, from each lot. The lot density is the average of all samples taken for that lot. The department will provide density results to the contractor weekly. The number of nuclear density tests required for legs of side roads at intersections, crossovers, turn lanes, and ramps with less than 750 tons per lift are specified in CMM 4-5-90.

460.3.3.3 Waiving Density Testing

- (1) The engineer may waive density testing for one or more of the following reasons:
1. It is not practical to determine density by the lot system.
 2. The contract contains less than 750 tons (680 Mg) of a given mixture type placed within the same layer and target maximum density category.
- (2) If the department waives density testing, the department will accept the mixture by the ordinary compaction procedure as specified in 450.3.2.6.2.

460.4 Measurement

- (1) The department will measure the HMA Pavement bid items acceptably completed by the ton as specified in 450.4.

460.5 Payment

460.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
460.1100	HMA Pavement Type E-0.3	TON
460.1101	HMA Pavement Type E-1	TON
460.1103	HMA Pavement Type E-3	TON
460.1110	HMA Pavement Type E-10	TON
460.1130	HMA Pavement Type E-30	TON
460.1132	HMA Pavement Type E-30X	TON
460.1700	HMA Pavement Type SMA	TON
460.2000	Incentive Density HMA Pavement	DOL

460.5.2 HMA Pavement

460.5.2.1 General

- (1) The department will pay for the HMA Pavement bid items at the contract unit price subject to one or more of the following adjustments:
1. Disincentive for density of HMA pavement as specified in 460.5.2.2.
 2. Incentive for density of HMA pavement as specified in or 460.5.2.3.
 3. Reduced payment for nonconforming smoothness as specified in 450.3.2.9.
 4. Reduced payment for nonconforming QMP HMA mixtures as specified in 460.2.8.2.1.7.
- (2) Payment for HMA Pavement Type E-0.3, E-1, E-3, E-10, E-30, and E-30x is full compensation for providing HMA mixture designs; for preparing foundation; for furnishing, preparing, hauling, mixing, placing, and compacting mixture; for QMP testing and aggregate source testing; and for all materials except asphaltic materials.
- (3) Payment for HMA Pavement Type SMA, is full compensation for providing HMA mixture designs; for preparing foundation; for furnishing, preparing, hauling, mixing, placing, and compacting the mixture; for QMP testing and aggregate source testing; and for all materials including asphaltic materials; for stabilizer, hydrated lime, and liquid antistripping agent if required.
- (4) If provided for in the plan quantities, the department will pay for a leveling layer, placed to correct irregularities in an existing paved surface before overlaying, under the pertinent paving bid item. Absent a plan quantity, the department will pay for a leveling layer as extra work.
- (5) Except for SMA mixes, the department will pay for asphaltic materials separately under the Asphaltic Materials bid items as specified in 455.5. Except for SMA mixes, hydrated lime or liquid antistripping agent, when required, is included in the contract price for the asphaltic material.
- (6) If the department waives density testing under 460.3.3.3, the department will not adjust pay under either 460.5.2.2 or 460.5.2.3.
- (7) Restore the surface after cutting density samples as specified in 460.3.3.2(1) at no additional cost to the department.

460.5.2.2 Disincentive for HMA Pavement Density

- (1) The department will administer density disincentives under the Disincentive Density HMA Pavement and the Disincentive Density Asphaltic Material administrative items. If the lot density is less than the specified minimum in table 460-3, the department will reduce pay based on the contract unit price for both the HMA Pavement and Asphaltic Material bid items for that lot as follows:

DISINCENTIVE PAY REDUCTION FOR HMA PAVEMENT DENSITY	
PERCENT LOT DENSITY BELOW SPECIFIED MINIMUM	PAYMENT FACTOR (percent of contract price)
From 0.5 to 1.0 inclusive	98
From 1.1 to 1.5 inclusive	95
From 1.6 to 2.0 inclusive	91
From 2.1 to 2.5 inclusive	85
From 2.6 to 3.0 inclusive	70
More than 3.0 ^[1]	—

^[1] Remove and replace the lot with a mixture at the specified density. When acceptably replaced, the department will pay for the replaced work at the contract unit price. Alternatively the engineer may allow the nonconforming material to remain in place with a 50 percent payment factor.

- (2) If the engineer directs placing HMA mixtures between October 15 and May 1 for department convenience as specified in 450.3.2.1(5), the department will not assess a density disincentive on pavement the department orders the contractor to place when the temperature, as defined in 450.3.2.1(2), is less than 36 F (2 C).

460.5.2.3 Incentive for HMA Pavement Density

- (1) If the lot density is greater than the minimum specified in table 460-3 and all individual air voids test results for that mixture placed during the same day are within +1.0 percent or - 0.5 percent of the design target in table 460-2, the department will adjust pay for that lot as follows:

INCENTIVE PAY ADJUSTMENT FOR HMA PAVEMENT DENSITY	
PERCENT LOT DENSITY ABOVE SPECIFIED MINIMUM	PAY ADJUSTMENT PER LOT ^[1]
From -0.4 to 1.0 inclusive	\$0
From 1.1 to 1.8 inclusive	\$300
More than 1.8	\$600

^[1] The department will prorate the pay adjustment for a partial lot.

- (2) The department will adjust pay under the Incentive Density HMA Pavement bid item. Adjustment under this item is not limited, either up or down, to the bid amount the schedule of items shows.
- (3) The department will restrict incentive payment as follows:
1. For shoulders paved integrally with the traffic lane, if the traffic lane does not meet incentive requirements, the department will not pay incentive on the integrally paved shoulder.
 2. If part of a lot is started or finished on a day when an individual air void test does not meet the air void criteria of 460.5.2.3(1), the entire lot is not eligible for incentive.