

**DATE:** 12/19/2000

**SUBJECT:** Hot Mix Asphalt (HMA)

Section 401, Plant Mix Pavements-General, of the 1990 Edition of the Mississippi Standard Specifications for Road and Bridge Construction is deleted in toto and replaced as follows:

**SECTION 907-401 - HOT MIX ASPHALT (HMA) - GENERAL**

~~**907-401.01-Description.** These specifications include general requirements that are applicable to all types of HMA along with the specific requirements for each particular mixture when deviations from the general requirements are necessary.~~

~~This work consists of the construction of one or more lifts of HMA in accordance with these specifications and the specific requirements for the mixture to be produced and in reasonably close conformity with the lines, grades, thicknesses and typical sections shown on the plans or established by the Engineer.~~

~~**907-401.01.1-Definitions:**~~

~~**Maximum Sieve Size**—Maximum sieve size is the smallest sieve size at which 100 percent of the aggregate passes.~~

~~**Nominal Maximum Sieve Size**—The nominal maximum sieve size is one sieve size larger than the first sieve to retain more than 10 percent of the aggregate.~~

~~**Maximum Density Line**—The maximum density line is a straight line plot on the FHWA 0.45 power gradation chart which extends from the zero origin point of the chart through the plotted point of the combined aggregate gradation curve on the nominal maximum sieve size.~~

~~**Mechanically Fractured Face**—An angular, rough, or broken surface of an aggregate particle created by crushing as determined by ASTM Designation: D 5821.~~

~~**907-401.02-Materials:**~~

~~**907-401.02.1-Component Materials:**~~

~~**907-401.02.1.1-General.** Component materials will be conditionally accepted at the plant subject to later rejection if incorporated in a mixture or in work which fails to meet contract requirements.~~

~~**907-401.02.1.2-Aggregates.** The source of aggregates shall meet the applicable requirements of Section 907-703.~~

~~**907-401.02.1.2.1-Coarse Aggregate Blend.** Mechanically fractured faces by weight of the combined mineral aggregate coarser than the No. 4 sieve:~~

~~12.5 mm 90 (two face)  
9.5 mm 90 (two face)~~

~~\* When used on routes requiring polymer modified asphalt, the top intermediate lift (19 mm mixture), including travel lane and adjacent lane, shall have at least 90 percent two fractured faces minimum. When placed on an existing Portland Cement Concrete surface, all intermediate lifts (19 mm mixture) shall have at least 90 percent fractured two faces minimum.~~

~~The maximum percentage by weight of flat and elongated particles, maximum to minimum dimension greater than 5, shall not exceed 10% for all mixtures. This shall be determined in accordance with ASTM D 4791, Section 8.4, on the combined mineral aggregate retained on the 3/8" sieve.~~

~~**907-401.02.1.2.2—Fine Aggregate Blend.** Of all the material passing the No. 8 sieve and retained on the No. 200 sieve, not more than 60 percent shall pass the No. 30 sieve.~~

~~Uncrushed natural sand shall pass the 3/8" sieve and may be used, excluding the content in RAP, in the percentages of the total mineral aggregate by weight set out in the following table:~~

Mixture	Maximum Percentage of Natural Sand by Total Weight of Mineral Aggregate		
	HT	MT	ST
<del>25 mm</del>	<del>10</del>	<del>10</del>	<del>20</del>
<del>19 mm</del>	<del>10</del>	<del>10</del>	<del>20</del>
<del>12.5 mm</del>	<del>10</del>	<del>10</del>	<del>20</del>
<del>9.5 mm</del>	<del>10</del>	<del>10</del>	<del>10</del>

Mixture:	25 mm	19 mm	12.5 mm	9.5 mm
Nominal Maximum Sieve Size:	<u>1 inch</u>	<u>3/4 inch</u>	<u>1/2 inch</u>	<u>3/8 inch</u>
<u>Sieve Size</u>	<u>Percent Passing</u>			
1-1/2 inch	100			
1 inch	90-100	100		
3/4 inch	89 max.	90-100	100	
1/2 inch	-	89 max.	90-100	100
3/8 inch	-	-	89 max.	90-100
No. 4	-	-	-	89 max.
No. 8	16-50	18-55	20-60	22-70
No. 200	4.0-9.0	4.0-9.0	4.0-9.0	4.0-9.0

~~For MT and HT mixtures, the combined aggregate gradation of the job mix formula, when plotted on FHWA 0.45 power chart paper, shall fall entirely below the Maximum Density Line on all sieve sizes smaller than the No. 4 sieve. However, MT and HT mixtures having a minimum fine aggregate angularity index of 44.0 (ASTM C1252, Method A) may be designed above the maximum density line.~~

~~The 9.5 mm mixtures shall have a minimum fine aggregate angularity of 44.0 for HT and MT mixtures and 40.0 for ST mixtures when tested on combined aggregate in accordance with ASTM C1252 Method A.~~

~~The minus No. 40 fraction of the combined aggregate shall be non-plastic when tested according to AASHTO T 90. The clay content for the combined aggregate used in underlying layers shall not exceed 1.0 percent, and when used in top layers shall not exceed 0.5 percent by weight of the total mineral aggregate when tested according to AASHTO T 88.~~

~~**907-401.02.1.3 Bituminous Materials.** Bituminous materials shall meet the applicable requirements of Section 907-702 for the grade specified.~~

~~Tack coat shall be the same neat grade asphalt cement used in the mixture being placed or those materials specified for tack coat in Table 410-A on the last page of Section 410. Emulsified asphalt shall not be diluted without approval of the Engineer.~~

~~**907-401.02.1.4 Blank.**~~

~~**907-401.02.1.5 Hydrated Lime.** Hydrated lime shall meet the requirements of 714.03.2 for lime used in soil stabilization.~~

~~**907-401.02.1.6 Asphalt Admixtures.** Additives for liquid asphalt, when required or permitted, shall meet the requirements of Subsection 702.08.~~

~~**907-401.02.1.7 Polymers.** Polymers for use in polymer modified HMA pavements shall meet the requirements of Subsection 907-702.08.3.~~

~~**907-401.02.2 Blank.**~~

~~obtain desired properties, antistripping agent and/or other materials.~~

~~The total amount of crushed limestone aggregate, when used in top lifts, shall not exceed 30 percent of the total combined aggregate by weight.~~

~~Hydrated lime shall be used in all HMA at the rate of one percent (1%) by weight of the total dry aggregate including aggregate in RAP, if used. The aggregate, prior to the addition of the hydrated lime, shall contain sufficient surface moisture. If necessary, the Contractor shall add moisture to the aggregate according to the procedures set out in Subsection 907-401.03.2.1.2.~~

~~The Contractor shall obtain a shipping ticket for each shipment of hydrated lime. The Contractor shall provide the District Materials Engineer with a copy of each shipping ticket from the supplier, including the date, time and weight of hydrated lime shipped.~~

~~Mixtures will require the addition of an antistripping agent when the Tensile Strength Ratio (MT-63) and/or the Boiling Water Test (MT-59) fail to meet the following criteria.~~

<del>Tensile Strength Ratio (TSR – MT-63)</del>	<del>_____</del>
<del>Wet Strength / Dry Strength</del>	<del>85 percent minimum</del>
<del>Interior Face Coating</del>	<del>95 percent minimum</del>
<del>Boiling Water Test (MT-59)</del>	<del>_____</del>
<del>Particle Coating</del>	<del>95 percent minimum</del>

~~Reclaimed asphalt pavement (RAP) materials may be used in the production of HMA in the percentages of the total mix by weight set out in the following table:~~

<del>HMA Mixture</del>	<del>Maximum percent RAP by total weight of mix</del>
<del>9.5 mm</del>	<del>15</del>
<del>12.5 mm Top Lift</del>	<del>15</del>
<del>12.5 mm Underlying Lift</del>	<del>30</del>
<del>19 mm</del>	<del>30</del>
<del>25 mm</del>	<del>30</del>

~~During HMA production, the RAP shall pass through a maximum 2-inch square sieve located in the HMA plant after the RAP cold feed bin and prior to the RAP weighing system.~~

~~Crushed reclaimed concrete pavement may be used as an aggregate component of all HMA pavements. When crushed reclaimed concrete pavement is used as an aggregate component, controls shall be implemented to prevent segregation. Crushed reclaimed concrete pavement aggregate shall be separated into coarse and fine aggregate stockpiles using the 3/8-in or 1/2-in sieve as a break point unless otherwise approved by the Engineer in writing.~~

**907-401.02.3.1.1 Mixture Properties:**

$N_{Initial}$	Less than 90.0
$N_{Maximum}$	Less than 98.0

<u>VMA CRITERIA</u>	<u>Minimum percent</u>
25 mm mixture	12.0
19 mm mixture	13.0
12.5 mm mixture	14.0
9.5 mm mixture	15.0

<u>DUST/BINDER RATIO</u>	
(Percent Passing No.200 / Effective Binder Percent)	0.8 to 1.6

**907-401.02.3.2 Job Mix Formula.** The job mix formula shall be established in accordance with Mississippi Test Method: MT-78, where N represents the number of revolutions of the gyratory compactor.

Compaction Requirements:	$N_{Initial}$	$N_{Design}$	$N_{Maximum}$
High Type (HT) Mixtures (19 mm, 12.5 mm & 9.5 mm)	8	96	152
Medium Type (MT) Mixtures (19 mm, 12.5 mm & 9.5 mm)	7	86	134
All Standard Type (ST) Mixtures; All other 25 mm HT & MT Mixtures	7	68	104

At least 10 working days prior to the proposed use of each mixture, the Contractor shall submit in writing to the Engineer a proposed job mix formula or request the transfer of a verified job mix formula as set forth in the latest edition of MDOT's Field Manual for HMA and TMD-11-78-00-000. The job mix formula shall be signed by a Certified Mixture Design Technician (CMDT).

The Department will perform the tests necessary for review of a proposed job mix formula for each required mixture free of charge one time only. A charge will be made for additional job mix formulas submitted by the Contractor for review.

Review of the proposed job mix formula will be based on percent maximum specific gravity at  $N_{Initial}$ ,  $N_{Design}$ , and  $N_{Maximum}$ , VMA @  $N_{Design}$ , resistance to stripping, and other criteria specified for the mixture.

The mixture shall conform thereto within the range of tolerances specified for the particular mixture. No change in properties or proportion of any component of the job mix formula shall be made without permission of the Engineer. The job mix formula for each mixture shall be in effect until revised in writing by the Engineer.

design number from the Central Laboratory.

When a change in source of materials, unsatisfactory mixture production results (such as segregation, bleeding, shoving, rutting over 1/8", raveling & cracking) or changed conditions make it necessary, a new job mix formula will be required. The conditions set out herein for the original job mix formula are applicable to the new job mix formula.

~~**907-401.02.4-Substitution of Mixture.** The substitution of a one (1) size finer mixture for an underlying lift shall require written permission of the State Construction Engineer. A 9.5 mm mixture may be substituted for the 12.5 mm mixture designated on the plans as the top lift or pre-leveling. The 19 mm mixture may be substituted for the 25 mm mixture in trench widening work. Any substitution of mixtures shall be of the same type. No other substitutions will be allowed. The quantity of substituted mixture shall be measured and paid for at the contract unit price for the mixture designated on the plans. The substitution of any mixture will be contingent on meeting the required total structure thickness and maintaining the minimum and/or maximum laying thickness for the particular substituted mixture as set out in the following table.~~

Mixture	Single Lift Laying Thickness (Inches)	
	Minimum	Maximum
25 mm	3	4
19 mm	2 1/4	3
12.5 mm	1 1/2	2
9.5 mm	1	1 1/2

~~**907-401.02.5-Contractor's Quality Management Program.**~~

~~**907-401.02.5.1-General.** The Contractor shall have full responsibility for quality management and maintain a quality control system that will furnish reasonable assurance that the mixtures and all component materials incorporated in the work conform to contract requirements. The Contractor shall have responsibility for the initial determination and all subsequent adjustments in proportioning materials used to produce the specified mixture. Adjustments to plant operation and spreading and compaction procedures shall be made immediately when results indicate that they are necessary. Mixture produced by the Contractor without the required testing or personnel on the project shall be subject to removal and replacement by the Contractor at no additional cost to the State.~~

~~**907-401.02.5.2-Personnel Requirements.** The Contractor shall provide at least one Certified Asphalt Technician I (CAT-I) full-time during HMA production at each plant site used to furnish material to the project. Sampling shall be conducted by a certified technician or by plant personnel under the direct observation of a certified technician. All testing, data analysis and data posting will be performed by the CAT-I or by an assistant under the direct supervision of the CAT-I. The Contractor shall have a Certified Asphalt Technician II (CAT-II) available to make any necessary process adjustments. Technician certification shall be in accordance with MDOT~~

~~907-401.02.5.3 Testing Requirements.~~ As a minimum, the Contractor's quality management program shall include the following:

- ~~(a) Bituminous Material. Provide Engineer with samples in a sealed one quart metal container at the frequency given in MDOT SOP TMD 20-04-00-000.~~
- ~~(b) Mechanically Fractured Face. Determine mechanically fractured face content of aggregates retained on the No. 4 sieve. Minimum of one test per day of production.~~
- ~~(c) Mixture Gradation. Conduct extraction tests for gradation determination on the mixture. Sample according to the frequency in paragraph (i) and test according to Mississippi Test Method MT-31.~~
- ~~(d) Total Voids and VMA. Determine total voids and voids in mineral aggregate (VMA), at  $N_{Design}$ , from the results of bulk specific gravity tests on laboratory compacted specimens. Sample according to the sampling frequency in paragraph (i) and test according to the latest edition of MDOT's Field Manual for HMA.~~
- ~~(e) Asphalt Content. Determine the asphalt content using one of the following procedures. Sample according to the sampling frequency in paragraph (i).
  - ~~— (1) Nuclear gauge. (Mississippi Test Method MT-6)~~
  - ~~— (2) Incinerator oven. (AASHTO T 308, Method A)~~~~
- ~~(f) Stripping Tests. Conduct a minimum of one stripping test at the beginning of each job-mix production and thereafter, at least once per each two weeks of production according to Mississippi Test Method: MT-63 and one stripping test per day of production according to Mississippi Test Method: MT-59. Should either the TSR (MT-63) or the boiling water (MT-59) stripping tests fail, a new antistrip additive or rate shall be established or other changes made immediately that will result in a mixture which conforms to the specifications; otherwise, production shall be suspended until corrections are made.~~
- ~~(g) Density Tests. Conduct density tests as necessary to control and maintain required compaction according to Mississippi Test Method: MT-16, Method C (nuclear gauge), or AASHTO T-166. (Note - The nuclear gauge may be correlated, at the Contractor's option, with the average of a minimum of five pavement sample densities.)~~
- ~~(h) Quality Control Charts. Plot the individual test data, the average of the last four tests and the control limits for the following items as a minimum:
  - ~~\_\_\_\_\_ Mixture Gradation (Percent Passing) Sieves:~~
    - ~~\_\_\_\_\_ 1/2 in, 3/8 in, No. 8, No. 30 and No. 200.~~
  - ~~\_\_\_\_\_ Asphalt Content, Percent~~
  - ~~\_\_\_\_\_ Maximum Specific Gravity~~
  - ~~\_\_\_\_\_ Total Voids @  $N_{Design}$ , Percent~~~~

each production day and displayed in the laboratory. Note any process changes or adjustments on the Air Voids chart.

- (i) ~~Sampling Frequency.~~ Conduct those tests as required above at the following frequency for each mixture produced based on the estimated plant tonnage at the beginning of the day:

<u>Total Estimated Production, tons</u>	<u>Number of Tests</u>
50-800	1
801-1700	2
1701-2700	3
2701+	4

- (j) ~~Sample Requirements.~~ Obtain the asphalt mixture samples from trucks at the plant. Obtain aggregate samples from cold feed bins or aggregate stockpile. Save a split portion of all mixture samples at the laboratory site in a dry and protected location for 14 calendar days. At the completion of the project, the remaining samples may be disposed of with the approval of the Engineer.

~~The above testing frequencies are for the estimated plant production for the day. If production is discontinued or interrupted, the tests will be conducted at the previously established sample tonnage points for the materials that are actually produced. If the production exceeds the estimated tonnage, sampling and testing will continue at the testing increments previously established for the day. A testing increment is defined as the estimated daily tonnage divided by the required number of tests from the table in 907-401.02.5.3 paragraph (i).~~

~~In addition to the above program, the following tests shall be conducted 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 (AASHTO T-11 and T-27)~~

~~Reclaimed Asphalt Pavement (RAP) Gradation (Mississippi Test Method MT-31)~~

~~Fine Aggregate Angularity for all 9.5 mm mixtures and all MT and HT mixtures designed above the maximum density line. (ASTM C-1252, Method A)~~

~~Testing of the aggregate and RAP stockpiles during production will be waived provided the Contractor provides the Engineer with gradation test results for the materials in the stockpile determined during the building of the stockpiles. The test results provided shall represent a minimum frequency of one per one thousand tons of material in the stockpile. If the Contractor continues to add materials to the stockpile during HMA production, the requirements for gradation testing during production are not waived.~~

~~**907-401.02.5.4-Documentation.** The Contractor shall document all observations, records of inspection, adjustments to the mixture, and test results on a daily basis. All tests conducted~~

that particular property. The Contractor shall record the results of observations and records of inspection as they occur in a permanent field record. The Contractor shall record all process adjustments and job mix formula (JMF) changes on the air void charts. The Contractor shall provide copies of all test data sheets and the daily summary reports on the appropriate Mississippi DOT forms to the Engineer on a daily basis. The Contractor shall provide a written description of any process change (including blend proportions) to the Engineer as they occur. Information provided to the Engineer must be received in the Engineer's office by no later than 9:00 AM the day after the HMA is produced. Fourteen days after the completion of the placement of the HMA, the Contractor shall provide the Engineer with the original testing records and control charts in a neat and orderly manner.

**907-401.02.5.5-Control Limits.** The following control limits for the job mix formula (JMF) and warning limits are based on a running average of the last four data points.

<u>Item</u>	<u>JMF Limits</u>	<u>Warning Limits</u>
Sieve % Passing		
1/2 in	± 5.5	± 4.0
3/8 in	± 5.5	± 4.0
No. 8	± 5.0	± 4.0
No. 30	± 4.0	± 3.0
No. 200	± 1.5	± 1.0
Asphalt Content, %	± 0.4	± 0.3
Total Voids @ $N_{Design}$ , %	± 1.3	± 1.0
VMA @ $N_{Design}$ , %	1.5	1.0

**907-401.02.5.6-Warning Bands.** Warning bands are defined as the area between the JMF limits and the warning limits.

**907-401.02.5.7-Job Mix Formula Adjustments.** A request for a JMF adjustment signed by a CAT-II may be made to the Engineer by the Contractor. Submit sufficient testing data with the request to justify the change. The requested change will be reviewed by the State Materials Engineer for the Department. If current production values meet the mixture design requirements, a revised JMF will be issued. Adjustments to the JMF shall conform to the latest edition of MDOT's Field Manual for HMA. Adjustments to the JMF to conform to actual production shall not exceed the tolerances specified for the JMF limits. Regardless of such tolerances, any adjusted JMF gradation shall be within the design master range for the mixture specified. **The JMF asphalt content may only be reduced if the production VMA meets or exceeds the minimum design VMA requirements for the mixture being produced.**

**907-401.02.5.8-Actions and Adjustments.** Based on the process control test results for any property in question, the following actions shall be taken or adjustments made when appropriate:

- (a) When the running average trends toward the warning limits, the Contractor shall consider taking corrective action. The corrective action, if any, shall be documented. All tests shall be part of the contract files and shall be included in the running average calculations.

- notifying the Engineer of the adjustments made.
- (d) ~~If the adjustment made under (c) improves the process such that the running average after four additional tests is within the warning limits, the Contractor may continue production with no reduction in payment.~~
  - (e) ~~If the adjustment made under (c) does not improve the process and the running average after four additional tests stays in the warning band, the mixture will be considered unsatisfactory. Reduced payment for unsatisfactory mixtures will be applied starting from the stop point to the point when the running average is back within the warning limits in accordance with Subsection 907-401.02.6.3.~~
  - (f) ~~Failure to stop production and make adjustments when required shall subject all mixture produced from the stop point to the point when the running average is back within the warning limits to be considered unsatisfactory. Reduced payment for unsatisfactory mixtures will be applied in accordance with Subsection 907-401.02.6.3.~~
  - (g) ~~If the running average exceeds the JMF limits, the Contractor shall stop production and make adjustments. Production shall only be restarted after notifying the Engineer of the adjustments made.~~
  - (h) ~~All materials for which the running average exceeds the JMF limits will be considered unacceptable and shall be removed and replaced by the Contractor at no additional cost to the State. The Engineer will determine the quantity of material to be replaced based on a review of the individual testing data which make up the running average in question and an inspection of the completed pavement. If the Engineer decides to leave the mixture in place because of special circumstances, the quantity of mixture, as defined above, will be paid for in accordance with Subsection 907-401.02.6.3.~~
  - (i) ~~Single test results shall be compared to 1.7 times the warning and JMF limits. If the test results verified by QA testing (within allowable differences in Subsection 907-401.02.6.2) exceed these limits, the pay factor provided in Subsection 907-401.02.6.3 will apply for the quantity of material represented by the test(s). Single test limits will be used for the acceptance of projects when insufficient tonnage is produced to require four (4) Contractor's tests.~~
  - (j) ~~The above corrective action will also apply for a mixture when the Contractor's testing data has been proven incorrect. The Contractor's data will be considered incorrect when; 1) the Contractor's tests and the Engineer's tests do not agree within the allowable differences given in Subsection 907-401.02.6.2 and the difference can not be resolved, or 2) the Engineer's tests indicates that production is outside the JMF limits and the results have been verified by the Materials Division. The Engineer's data will be used in place of the Contractor's data to determine the appropriate pay factor.~~

~~**907-401.02.5.9-Test Strip.** At the beginning of placement for each lift, except for temporary work of short duration, detours, and bridge replacement projects having 1,000 feet or less of pavement on each side of a structure, the Contractor shall construct a test strip of a maximum four hours duration for the purpose of evaluating the properties and determining the compactability of the mixture. When there are multiple bridge sites on a bridge replacement project, each site will be considered separately. The Contractor shall select an evaluation section from the test strip for compaction testing according to the procedures in Chapter 7 of the latest edition of MDOT's Field Manual for HMA. When mixture and density test results~~

~~907-401.02.6—Standards of Acceptance.~~

~~907-401.02.6.1—General.~~ Acceptance for mixture quality (VMA and total voids @  $N_{Design}$ , gradation, and asphalt content) will be based on random samples tested in accordance with the latest edition of MDOT's Field Manual for HMA. Pavement densities and smoothness will be accepted by lots as set out in ~~907-401.02.6.4 and 907-401.02.6.5.~~

~~907-401.02.6.2—Assurance Program for Mixture Quality.~~ The rounding of test results will be in accordance with Subsection 700.04.

The Engineer will conduct assurance tests on split samples taken by the Contractor. These samples may be the regular quality management samples or a sample chosen by the Engineer anytime during production. The frequency will be equal to or greater than ten percent of the tests required for the Contractor quality control and the data will be provided to the Contractor within two asphalt mixture production days after the sample has been obtained by the Engineer. At least one sample shall be tested from the first two days of production. The Engineer may select any or all of the Contractor retained samples for assurance testing. All testing and data analysis shall be performed by a Certified Asphalt Technician-I (CAT-I) or by an assistant under the direct supervision of the CAT-I. Certification shall be in accordance with MDOT SOP TMD-22-10-00-000, MDOT HMA Technician Certification Program. The Department shall post a chart giving the names and telephone numbers for the personnel responsible for the assurance program.

The Engineer shall be allowed to inspect measuring and testing devices to confirm both calibration and condition. The Contractor shall calibrate and correlate all testing equipment in accordance with the latest version of the Department's Test Methods.

Random differences between the Contractor's and Engineer's split sample test results will be considered acceptable if within the following limits:

Item	Allowable Differences
Sieve—% Passing	
3/8-in and above	6.0
No. 4	5.0
No. 8	4.0
No. 30	3.5
No. 200	2.0
AC Content	0.4
Specimen Bulk SG (Gmb) @ $N_{Design}$	0.030
Maximum SG (Gmm)	0.020

In the event that; 1) the comparison of the Contractor's and Engineer's test results are outside the allowable differences in the above table, or 2) if a bias exists between the results (such that one of the results is predominately higher or lower than the other) and the Engineer's results fail to meet the JMF control limits, the Engineer will investigate the reason immediately. The Engineer's investigation may include testing of the remaining split samples, review and observation of the Contractor's testing procedures and equipment, and a comparison of split sample test results by

appropriate payment for the mixture will be based on the procedures specified in Subsection 907-401.02.5.8 (see Subsection 907-401.02.5.8(j)).

~~The Engineer will periodically witness the sampling and testing being performed by the Contractor. The Engineer, both verbally and in writing, will promptly notify the Contractor of any observed deficiencies. When differences exist between the Contractor and the Engineer which cannot be resolved, a decision will be made by the State Materials Engineer, acting as the referee, and will in writing promptly notify the Contractor. If the deficiencies are not corrected, the Engineer will stop production until corrective action is taken.~~

~~**907-401.02.6.3 Acceptance Procedure for Mixture Quality.** All obviously defective material or mixture will be subject to rejection by the Engineer. Such defective material or mixture shall not be incorporated into the finished work. If the defective material has already been placed in the work, the material shall be removed and replaced at no additional cost to the State.~~

~~The Engineer will base final acceptance of the asphalt mixture production on the results of the Contractor's testing for total voids and VMA @  $N_{Design}$ , gradation, and asphalt content as verified by the Engineer in the manner hereinbefore described and the uniformity and condition of the completed pavement. Areas of pavement that exhibit nonuniformity or failures (materials or construction related) such as but not limited to segregation, bleeding, shoving, rutting over  $\frac{1}{8}$ ", raveling, slippage, or cracking will not be accepted. Such areas will be removed and replaced at no additional cost to the State.~~

~~Bituminous mixture placed prior to correction for deficiencies in VMA and total voids @  $N_{Design}$ , gradation, or asphalt content, as required in 907-401.02.5.8 and determined by the Engineer satisfactory to remain in place will be paid for in accordance with the following pay factors times the contract unit price per ton:~~

**Pay Factor for Mixture Quality \***

Item	Produced in Warning Bands	Produced Outside JMF Limits (Allowed to Remain in Place)
Gradation	0.90	0.75
Asphalt Content	0.85	0.75
Total Voids @ $N_{Design}$	0.70	0.50
VMA @ $N_{Design}$	0.90	0.75

\*—The minimum single payment will apply.

~~**907-401.02.6.4 Acceptance Procedure for Density.** Each completed lift will be accepted with respect to compaction on a lot to lot basis from density tests performed by the Department. Material produced and placed during the test strip(s) for each lift will be designated as separate lots. For normal production days, divide the production into approximately equal lots as shown in the following table. When cores are being used for the compaction evaluation, randomly obtain one core from each lot. When the nuclear density gauge is being used for compaction evaluation, obtain two random readings from each lot and~~

## Lot Determination

<u>Daily Production—Tons</u>	<u>Number of Lots</u>
0-300	1
301-600	2
601-1000	3
1001-1500	4
1501-2100	5
2101-2800	6
2801+	7

~~907-401.02.6.4.1—Roadway Density.~~ When it is determined that the density for a lot is below 92.0 percent but not lower than 90.0 percent of maximum density, the Contractor will have the right to remove and replace the lot(s) not meeting the specified density requirements in lieu of accepting reduced payment for the lot(s).

When it is determined that the density for a lot is above 96.0 percent, the Engineer shall notify the Contractor who will make plant adjustments to resolve the problem.

When it is determined that the density for a lot is below 90.0 percent, the lot(s), or portions thereof shall be removed and replaced in accordance with Chapter 7 of the latest edition of MDOT's Field Manual for HMA at no additional cost to the State. A corrected lot will be retested for approval. No resampling will be performed when pavement samples are used for determining density.

At any time the average daily compaction (the total of the percent compaction for the lots produced in one day divided by the total number of lots for the day) does not meet 92.0 percent compaction or more for two consecutive days, the Contractor shall notify the Engineer of proposed changes to the compactive effort. If the average daily compaction does not meet 92.0 percent compaction or more for a third consecutive day, the Contractor shall stop production and construct another test strip to establish proper compaction procedures.

Each lot of work found not to meet the density requirement of 92.0 percent of maximum density may remain in place with a reduction in payment as set out in the following table:

1.00	92.0 and above
0.90	91.0 - 91.9
0.70	90.0 - 90.9

~~\*\* Any lot or portion thereof with a density of less than 90.0 percent of maximum density shall be removed and replaced at no additional cost to the State.~~

~~The compaction pay factors and mixture quality pay factor (Subsection 907-401.02.6.3) will each apply separately. However, the combined pay factor shall not be less than 0.50 for any mixture allowed to remain in place.~~

~~**907-401.02.6.4.2-Trench Widening Density.** When it is determined that the density for a trench widening lot is below 91.0 percent but not lower than 89.0 percent of maximum density, the Contractor will have the right to remove and replace the lot(s) not meeting the specified density requirements in lieu of accepting reduced payment for the lot(s).~~

~~When it is determined that the density for a trench widening lot is above 95.0 percent, the Engineer shall notify the Contractor who will make plant adjustments to resolve the problem.~~

~~When it is determined that the density for a trench widening lot is below 89.0 percent, the lot(s), or portions thereof shall be removed and replaced in accordance with Chapter 7 of the latest edition of MDOT's Field Manual for HMA at no additional cost to the State. A corrected lot will be retested for approval. No resampling will be performed when pavement samples are used for determining density.~~

~~At any time the daily compaction (the total of the percent compaction for the lots produced in one day divided by the total number of lots for the day) does not meet 91.0 percent compaction or more for two consecutive days, the Contractor shall notify the Engineer of proposed changes to the compactive effort. If the average daily compaction does not meet 91.0 percent compaction or more for a third consecutive day, the Contractor shall stop production and construct another test strip to establish proper compaction procedures.~~

~~Each lot of trench widening work found not to meet the density requirement of 91.0 percent of maximum density may remain in place with a reduction in payment as set out in the following table:~~

~~**PAYMENT SCHEDULE FOR COMPACTION  
(TRENCH WIDENING WORK)**~~

<del>Pay Factor</del>	<del>Lot Density *** % of Maximum Density</del>
<del>1.00</del>	<del>91.0 and above</del>
<del>0.90</del>	<del>90.0 - 90.9</del>
<del>0.70</del>	<del>89.0 - 89.9</del>

~~\*\*\* Any lot or portion thereof with a density of less than 89.0 percent of maximum density shall be removed and replaced at no additional cost to the State.~~

**907-401.02.6.5--Acceptance Procedure for Pavement Smoothness.** When compaction is completed, the lift shall have a uniform surface and be in reasonably close conformity with the line, grade and cross section shown on the plans.

The smoothness of each applicable lift will be determined by using a profilograph to produce a profilogram (profile trace) at each designated location. The surface shall be tested and corrected to a smoothness index as described herein with the exception of those locations or specific projects that are excluded from a smoothness test with the profilograph.

The profilograph, furnished and operated by the Contractor under supervision of the Engineer, shall consist of a frame at least 25 feet in length supported upon multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern so that no two wheels will simultaneously cross the same bump. A profile is to be recorded from the vertical movement of a sensing mechanism. This profile is in reference to the mean elevation of the contact points established by the support wheels. The sensing mechanism, located at the mid-frame, may consist of a single bicycle-type wheel or a dual-wheel assembly consisting of either a bicycle-type (pneumatic tire) or solid rubber tire vertical sensing wheel and a separate bicycle-type (pneumatic tire) longitudinal sensing wheel. The wheel(s) shall be of such circumference(s) to produce a profilogram recorded on a scale of one (1) inch equal to 25 feet longitudinally and one (1) inch equal to one (1) inch (full scale) vertically. Motive power may be provided manually or by the use of a propulsion unit attached to the center assembly. In operation, the profilograph shall be moved longitudinally along the pavement at a speed no greater than 3 MPH so as to reduce bounce as much as possible. The testing equipment and procedure shall comply with the requirements of Department SOP.

The Contractor may elect to use a computerized version of the profilograph in lieu of the standard profilograph. If the computerized version of the profilograph is used, it shall meet the requirements of Subsection 907-401.02.6.6.

The smoothness of each applicable lift will be determined for traffic lanes, auxiliary lanes, climbing lane and two-way turn lanes. Areas excluded from a smoothness test with the profilograph are acceleration and deceleration lanes, tapered sections, transition sections (for width), shoulders, crossovers, ramps, side street returns, etc. The roadway pavement on bridge replacement projects having 1,000 feet or less of pavement on each side of the structure will be excluded from a test with the profilograph. Pavement on horizontal curves having a radius of less than 1,000 feet at the centerline and pavement within the superelevation transition of such curves are excluded from a test with the profilograph. A single lift overlay is excluded unless the existing surface profile has been corrected by milling or other methods as provided by the contract. The profilogram shall terminate 15 feet from each transverse joint that separates the pavement from a bridge deck, bridge approach slab or existing pavement not constructed under the contract.

A profilogram will be made for each applicable lift. The measurements will be made in the outside wheel path of exterior lanes and either wheel path of interior lanes. The wheel path is designated as being located three feet from the edge of pavement or longitudinal joint. The testing will be limited to a single profilogram for each lift of a lane except that a new profilogram will be made on segments that have been surface corrected. When surface

price adjustment was more than 100 percent, payment will be made on the new contract price adjustment, not to exceed the original contract price adjustment.

2. When the new contract price adjustment is more than 100 percent and the original contract price adjustment was 100 percent or less, payment will be 100 percent of the HMA unit bid price.
3. When the new contract price adjustment is 100 percent or less, payment will be made on the new contract price adjustment.

Otherwise, payment will be made based on the results of the original profilogram. Other profilograms may be made only to define the limits that are out of tolerance.

Each applicable lift will be accepted on a lot to lot basis for pavement smoothness, except when the profile index requirement of the lift is 7 inches per mile, no individual segment of the lift with a profile index greater than 10 inches per mile shall be allowed to remain in place without correction. For the purpose of determining pavement smoothness and contract price adjustment for rideability (Subsection 907-403.03.2), the size of a lot will be designated as a day's production. Each lot will be sub-divided into sections which terminate at bridges, transverse joints or other interruptions. Each section will be sub-divided into segments of 528 feet with the remainder of the section also considered a segment. The last 15 feet of a day's lift may not be obtainable until the lift is continued and for this reason may be included in the subsequent lot.

A profile index will be determined for each lot as inches per mile in excess of the blanking band which is simply referred to as the "Profile Index". From the profilogram of each segment, the scallops above and below the blanking band are totaled in tenths of an inch. The totaled count of tenths for all segments in a lot is converted to inches per mile to establish a smoothness profile index for that lot.

Individual bumps and/or dips that are identified on the profilogram by locating vertical deviations that exceed four tenths of an inch when measured from a chord length of 25 feet or less shall be corrected regardless of the profile index value of the lot. Surface correction by grinding shall be in accordance with Subsection 907-401.02.6.7. The Contractor shall also make other necessary surface corrections to ensure that the final profile index of the lot meets the requirements of 907-403.03.2, Smoothness Tolerances.

Lot(s) exceeding the accepted profile index value shall be corrected as specified in 907-403.03.4. When a correction is required under this specification to an individual segment whose profile index is greater than 10 inches per mile, the correction shall be as specified in 907-403.03.4. All such correction shall be at the expense of the Contractor.

Scheduling will be the responsibility of the Contractor with approval of the Engineer, and the tests shall be conducted within 72 hours after each day's production unless authorized otherwise by the Engineer. The Contractor will be responsible for traffic control associated with this testing operation.

#### **907-401.02.6.6--Computerized Profilograph.**

Vertical displacement shall be sampled every three (3) inches or less along the roadway. The profile data shall be bandpass filtered in the computer to remove all spatial wavelengths shorter than two (2) feet. This shall be accomplished by a third order, low pass Butterworth filter. The resulting band limited profile will then be computer analyzed according to the California Profilograph reduction process to produce the required inches per mile index. This shall be accomplished by fitting a linear regression line to each 528 feet of continuous pavement section. This corresponds to the perfect placement of the blanking band bar by a human trace reducer. Scallops above and below the blanking band are then detected and totaled according to the California protocol. Bump/Dip analysis shall take place according to the California Profilograph reduction process.

The computerized profilograph shall be capable of producing a plot of the profile and a printout which will give the following data: Stations every twenty five (25) feet, bump/dip height and bump/dip length of specification (4/10 of an inch and 25 feet respectively), the blanking band width, date of measurement, total profile index in inches per mile for the measurement, total length of the measurement, and the raw inches for each tenth mile segment.

**907-401.02.6.6.2—Mechanical Requirements.** The profilograph shall consists of a frame twenty five (25) feet long supported at each end by multiple wheels. The frame shall be constructed to be easily dismantled for transporting. The profilograph shall be constructed from aluminum, stainless steel and chromed parts. The end support wheels shall be arranged in a staggered pattern such that no two wheels cross a transverse joint at the same time. The relative smoothness shall be measured by the vertical movement of an eight (8) inch or larger diameter sensing wheel at the midpoint of the 25-foot frame. The horizontal distance shall be measured by a twenty (20) inch or larger diameter pneumatic wheel. This profile shall be the mean elevation referenced to the twelve points of contact with the pavement established by the support wheels. Recorded graphical trace of the profile shall be on a scale of one inch equals one inch (full scale) vertical motion of the sensing wheel and one inch equals 25 feet horizontal motion of the profilograph.

**907-401.02.6.6.3—Computer Requirements.** The computer shall have the ability to produce output on sight for verification. The computerized output shall indicate the profile index for each specified section of roadway. Variable low and high pass third-order Butterworth filtering options shall be available. The printout shall be capable of showing station marks automatically on the output. Blanking band positioning for each specified section of the roadway shall be placed according to the least squares fit line of the collected data. Variable bump and dip tests shall be available to show “must correct” locations on the printout. The computer must have the ability to display on screen “must correct” conditions and alert the user with an audible warning when a “must correct” location has been located. The computer must have the ability to store profile data for later reanalysis. The measurement program must be menu driven and IBM compatible. User selected options, identification, calibration factors, and time and date stamps shall be printed at the top of each printed report for verification. The control software must be upgradeable. A power source shall be included for each profilograph and be capable of supplying all power needs for a full days testing.

**907-401.02.6.7.1--Diamond Grinding.** Grinding of asphalt surfaces shall consist of diamond grinding the existing asphalt pavement surface to remove surface distortions to achieve the specified surface smoothness requirements.

**907-401.02.6.7.2--Equipment.** The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture pavement surfaces with diamond blades. The effective wheel base of the machine shall not be less than 12.0 feet. It shall have a set of pivoting tandem bogey wheels at the front of the machine and the rear wheels shall be arranged to travel in the track of the fresh cut pavement. The center of the grinding head shall be no further than 3.0 feet forward from the center of the back wheels.

The equipment shall be of a size that will cut or plane at least 2.0 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the work area. The equipment shall be capable of grinding the surface without causing spalls at joints, or other locations.

**907-401.02.6.7.3--Construction.** The construction operation shall be scheduled and proceed in a manner that produces a uniform finish surface. Grinding will be accomplished in a manner to provide positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane.

The operation shall result in pavement that conforms to the typical cross-section and the requirements specified in 907-401.02.6.7.4. It is the intent of this specification that the surface smoothness characteristics be within the limits specified.

The Contractor shall establish positive means for removal of grinding residue. Solid residue shall be removed from pavement surfaces before it is blown by traffic action or wind. Residue shall not be permitted to flow across lanes used by public traffic or into gutters or drainage facilities, but may be allowed to flow into adjacent ditches.

**907-401.02.6.7.4--Finished Pavement Surface.** The grinding process shall produce a pavement surface that is smooth and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. The peaks of the ridges shall not be more than 1/16 inch higher than the bottoms of the grooves.

The finished pavement surface will be measured for riding quality. The grinding shall produce a riding surface which does not exceed either the specified profile index or the specified bump and dip limit.