WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR CONTRACTOR QUALITY CONTROL OF ASPHALT CONCRETE

1. PURPOSE

1.1 To provide a method for daily monitoring and quality control of Asphalt Concrete.

1.2 To provide plant personnel with criteria upon which to base decisions of continuing or ceasing plant production.

2. SCOPE

2.1 This materials procedure shall be applicable to all Section 401 Asphalt Concrete types relative to compliance with Job Mix Formula (JMF) control limits as specified in the governing specifications.

3. DEFINITIONS

3.1 Job Mix Formula - The specification for a single mix produced at a single plant. This mix may be specific to a single project or be used on multiple projects if the basic design criteria (design compaction level and PG Binder grade) are the same.

3.2 Field Design Verification Samples and Tests - Those samples taken and tests conducted by the contractor to verify that a mix design can be produced within the limits of the criteria set forth by this Materials Procedure. These samples are taken during the initial use of each mix design or whenever circumstances described in this MP require a new field design reverification. These samples should not be confused with the Division verification samples that are used to determine specification compliance.

3.3 Quality Control Samples and Tests - Those samples taken and tests conducted by the Producer/Contractor to monitor and control the production of this product.

3.4 Verification Samples and Tests - Those samples taken and tests conducted by the Division to determine specification compliance.

4. DOCUMENTATION

4.1 The Contractor shall maintain adequate records of all testing and records of any production changes required to control their product. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, and the nature of corrective action taken. The Contractor's documentation procedures will be subject to the review and approval of the Division at any time during the progress of the work being performed.

4.2 Forms and Distribution: All test data shall be documented on forms provided by the Division. The original copy of the completed form shall be delivered to the District Materials Supervisor. One copy of each completed form is to be retained by the Contractor until the project is completed. Testing shall be conducted using only the approved test methods listed in Section 401.5.1 of the Standard Specification unless specified otherwise in contract documents. Asphalt content and gradation test results shall be recorded on T417. Mix design property test results shall be recorded on form T406. To be an effective quality control program, tests must be completed in a regular and timely manner.

4.3 The Contractor shall take prompt action to correct conditions that have resulted, or could result, in the submission to the Division of materials and products that do not conform to the requirements of the Contract documents. The Contractor shall establish a detailed plan of action regarding the disposition of non-specification material. In the event that non-specification material is incorporated into the project, the Division shall be notified immediately.

4.4 All Asphalt Concrete component materials shipped to the plant must have proper documentation, which identifies the type and source of each material. This information shall be made accessible to the Division for review at any time.

5. JOB MIX FORMULA FIELD DESIGN VERIFICATION

5.1 For each JMF, a field design verification shall be conducted during the first days of plant production for the purpose of demonstrating that the mix can be produced within the specified tolerances set forth in this MP.

5.2 This field design verification shall consist of a randomly selected Asphalt Concrete sample taken in accordance with AASHTO T168 for each three hours of production, with no more than three samples in one day. A minimum of three samples are required for verification, however, three additional samples are required if none of the first three samples are completely within the specification limits. Samples used for gradation analysis during the verification process shall be obtained from the asphalt ignition oven samples (AASHTO T308). If there is a problem with major aggregate breakdown affecting the gradation test results when using the ignition oven, gradation samples may be obtained from hot bins, cold feeds, or extracted Asphalt Concrete samples.

5.3 Field design verification testing shall not be conducted if less than 200 tons (180 Mg) of material is to be produced in a single day. In such cases daily quality control testing shall be conducted in accordance with Section 6. and shall meet the gradation requirements of the Table 401.02.27B, the design asphalt content within ± 0.4%, and a minimum VMA of 0.5% below the design criteria specified in MP 401.02.22. The percent air voids shall be within the range of 2.5 – 6.5 percent for Base-I and 2.5 – 5.5 percent for all other mixes. Stability and flow shall be within the design limits specified in MP 401.02.22.

5.4 The field design verification mix property requirements are listed in Table 401.02.27A. Field design verification test results shall be documented on Form T408. Gradation requirements for the field design verification samples shall be as indicated in Table

401.02.27B. The gradation results shall fall within the limits of each specified control point with the exceptions as noted on the No. 8 and No. 16 sieves. Gradation results for all sieves listed in this table for each mix type shall be documentedon Form T421.

TABLE 401.02.27A

Mix Property Field Design Verification Requirements

Property	Field Verification Tolerances
Asphalt Content (%)	JMF ± 0.4 %
Air Voids (%) – Base-I	3.0 – 6.0 %
Air Voids (%) – All other mix types	3.0 – 5.0 %
Voids in Mineral Aggregate (VMA) %	Min. of 0.5 % Below Design Criteria
Stability (Newtons)	Minimum Design Criteria
Flow (0.25 mm)	Limits of Design Criteria

TABLE 401.02.27B

Design Aggregate Gradation Requirements for Marshall Mixtures (Note 8)

TYPE OF MIX	Base-I	Base-II (Patch & Level)	Wearing-IV (Note 9)	Wearing-I (Scratch)	Wearing-III
SIEVE SIZE	Nominal Max Size 1 ½ in (37.5 mm)	Nominal Max Size ¾ in (19 mm)	Nominal Max Size ¾ in (19 mm)	Nominal Max Size 3/8 in (9.5 mm)	Nominal Max Size No. 4 (4.75 mm)
2 in (50 mm)	100				
1 ½ in (37.5 mm)	90 – 100				
1 in (25 mm)	90 max	100	100		
¾ in (19 mm)	-	90 – 100	90 – 100		
½ in (12.5 mm)	-	90 max	90 max	100	
3/8 in (9.5 mm)	-	-	-	85 - 100	100
No. 4 (4.75 mm)	-	-	47min	80 max	90 – 100
No. 8 (2.36 mm)	15 – 36	20 – 50	20 – 50	30 – 55	90 max
No. 16 (1.18 mm)	-	-	-	-	40 – 65
No. 30 (600 µm)	-	-	-	-	-
No. 50 (300 µm)	-	-	-	-	-
No. 200 (75 µm)	1.0 – 6.0	2.0 – 8.0	2.0 – 8.0	2.0 – 9.0	3.0 – 11.0

Note 8: For quality control of the mixture the allowable tolerances for each JMF shall be the specified design control points shown in Table-3 of MP 401.02.22 with the exception that a Wearing-III mix shall have a tolerance limit of the JMF ± 5% on the 1.18 mm (No. 16) sieve, and all other mix types shall have a tolerance limit of the JMF ± 6% on the 2.36 mm (No.8) sieve. These tolerances shall also be applied to the mix design and shall be documented on the T-400 Form. The tolerances shall not fall outside of the specified control points of Table-3 of MP 401.02.22.
Note 9: In addition, a Wearing-IV mix shall have a tolerance limit of the JMF ± 5% on the 4.75 mm (No. 4) sieve, but not below the minimum requirement.

5.5 After each of the field design verification samples is tested, the results shall be evaluated to determine conformance to the verification requirements. If any test results fall outside the allowable tolerance limits established in Table 401.02.27A or Table 401.02.27B then steps must be taken to make any necessary production adjustments to bring the mix back to within specification limits. Steps can include bin changes as described in 5.8, as well as asphalt content adjustments of ± 0.2% from the approved JMF target. If, after three samples, all of the design criteria and gradation requirements are within the allowable tolerance limits on at least one sample, then verification of the design is complete. If all criteria is not met, then three additional samples shall be tested. If, after six samples, the Division determines that the mix cannot be produced within specification limits, then a new mix design will be required.

5.6 The verified JMF target for asphalt content shall be selected at a value within ± 0.2% of the approved design asphalt content using the results of the field verification testing to determine the appropriate value. The VMA production target shall be determined from the field verification test data at a value which also provided an air void content that was at or near the JMF target air void content based on the results of the field verification testing. This value may be adjusted to optimize the ± 1.0 tolerance of Table 401.02.27C if the result is near the minimum allowable requirement. The production target for air voids shall remain at the medium value of the design.

5.7 If the field design verification process is successful, then a new target maximum density shall be established for compaction control by averaging the maximum density results of all of the samples used for verification of the mix. The District will forward the verification test data to the Contract Administration Division, Materials Section.

5.8 The maximum allowable blend change for a mix design shall be ten percent on any single aggregate component. If an aggregate blend change of more than five percent on any single aggregate component is required, the Contractor shall evaluate the mix to determine whether or not the volumetric properties, FA ratio, and coarse aggregate angularity are adversely affected by the change in blended aggregates. The Contractor shall also determine whether or not the aggregate gradation requirements are still being maintained. The calculations used in this evaluation shall be provided to the District. The District will review and verify the results of this evaluation. If the District determines that any of the above-mentioned properties are adversely affected by the blend adjustment, then they may revoke the change in the JMF. If the JMF volumetric properties cannot be maintained without these non-approved changes, then the contractor will be required to provide a new mix design.

5.9 After the field design verification has been successfully completed and quality control testing (as described in Section 6.) has begun, the Contractor shall monitor the maximum specific gravity of the mix for any consistent change. If, over a five-sample period, there is an average change in the maximum specific gravity of ± 0.02 or greater from the verified value of the mix then a field design reverification may be required. A reverification shall not be conducted if the averages of the % asphalt, % air voids, %VMA, stability and flow of the five quality control samples do not meet the requirements of Table 401.02.27C. The District will review the Contractor's test data, compare it to their verification sample test data, and determine if a reverification is necessary. If the District determines that a reverification of the mix is needed, a new blended aggregate bulk specific gravity shall also be determined for the mix before the field reverification begins. The District will forward the reverification and bulk aggregate specific gravity test results to the Contract Administration Division, Materials Section.

5.10 All approved mix designs shall be reverified on the first project on which they are used in any subsequent years as long as there are no changes to the design specifications that would require a new mix design. In addition, the blended aggregate bulk specific gravity shall be determined before reverification begins.

6. QUALITY CONTROL REQUIREMENTS

6.1 After the field design verification has been successfully completed, quality control sampling and testing shall begin. If production is to continue for four hours or more after the last field design verification sample was taken, then the first randomly selected quality control sample shall be taken within that remaining time period. If production continues for less than four hours after the last field design verification sample was taken, then the first randomly selected quality control sample will not be required until the next production day.

6.2 The allowable design property tolerances for each JMF shall be as set forth in Table 401.02.27C. The gradation of the mix shall continue to pass through the control points within the tolerances established in Table 401.02.27B.

6.3 Adjustments to the accepted JMF aggregate proportions shall be made only for the purpose of maintaining the gradation requirements of Table 401.02.27B and/or the design properties of Table 401.02.27C. The maximum allowable adjustment shall be as indicated in Section 5.8. The minimum sample requirements of the approved quality control plan will be sufficient when the allowable adjustments are made as a result of deficient or borderline test properties of the previous test sample.

TABLE 401.02.27C

Quality Control Mix Property Tolerances

Property	Production Tolerances
Asphalt Content (%)	Verified JMF ± 0.4 %
Air Voids (%)	JMF ± 1.5 %
Voids in Mineral Aggregate (VMA) %	Verified JMF ± 1.0 % with a minimum of 0.5 % below the minimum design criteria
Stability (Newtons)	Minimum Design Criteria
Flow (0.25 mm)	Limits of Design Criteria

6.4 If the previous test sample meets all specification requirements, but the Contractor later determines that the gradation of the material entering the plant has changed, then an aggregate proportion adjustment up to two percent will be allowed without requiring an additional test sample. However, if more than one such change is made during the production day, then an additional test sample beyond that specified in the approved quality control plan will be required for each adjustment.

6.5 Minimum Sampling and Testing Frequency: During each day of plant production a minimum of one sample shall be taken for production periods of six hours or less. When the production period exceeds six hours, a minimum of one sample for each half of the production period shall be taken. If the production period exceeds twelve hours, a third sample shall be taken. The Contractor's sampling frequency shall be in accordance with their approved Quality Control Plan.

6.6 For the purpose of administration, the quantity of material represented by an individual test shall be determined as follows: the first sample taken after the field design verification has been approved shall represent the quantity produced from the beginning of production after field design verification until the time the sample was taken. The second sample shall represent the material produced between the time that the first and second samples were taken and so on. The last sample taken prior to a halt in production under a given JMF shall represent that quantity of material produced from the time that the next to last sample was taken until production was stopped.

6.7 Sampling and testing for evaluation of compliance with the verified JMF shall be as follows: Obtain a sample large enough for determining the percent asphalt, percent air voids, percent VMA, and gradation of the mix in accordance with the specified test methods listed in Section 401.5.1 of the Specifications. If excessive aggregate breakdown in the ignition oven prevents proper gradation analysis, aggregate samples may be obtained from hot bins, cold feeds, or extracted Asphalt Concrete samples.

6.8 A four-sample average shall be used for the purpose of determining whether or not the material meets specification requirements. The test results of the first four samples shall be averaged. After the fifth sample is taken a four-sample moving average shall begin. This first moving average shall consist of the average of the second through fifth test samples. Each time a new sample is taken a new moving average shall be calculated by

averaging the new sample with the previous three samples. The moving average shall continue through a single paving season (one calendar year).

6.9 In cases where production is limited and less than four samples of the specified mix design are taken, then the average shall consist of the total number of samples taken during the paving season in accordance with the Quality Control Plan. A new four sample average shall be established at the first startup of a new paving season after the field design verification has been completed.

6.10 The Contractor shall maintain control charts for percent asphalt, percent air voids, and percent VMA. These control charts shall be prepared in accordance with the guidelines of MP 300.00.51. As an alternative method, the control charts may be prepared with a personal computer using software that can generate such charts and provide a distinct graphic representation of all data points. Data points required on the control charts are the daily individual Contractor quality control tests, district verification sample tests, and the moving average of every four Contractor quality control tests. All data points shall be calculated to the nearest 0.1 percent.

6.11 For hand drawn charts, the quality control test data points shall be represented by a small blue circle symbol "O" and connected by a dashed line. The four sample moving average data points shall be represented by a small red square symbol "■" and connected by a solid line. District verification sample test data points shall be represented by a small red circle symbol "O", but shall not be connected. The upper and lower tolerance limits of the test properties that were established through the field design verification described in Section 6. shall be represented by solid horizontal lines.

6.12 If the computer-generated control chart cannot be produced using the symbols and lines described above, then a graph legend shall be included which shall indicate the graphic symbols used to represent the required data points and lines.

6.13 The quality control charts shall be kept up to date and placed in a location that is easily accessible to the Division for review at any time.

7. DEGREE OF NONCONFORMANCE

7.1 Should the four-sample average of test values for percent asphalt, percent air voids, or percent VMA fall outside the verified JMF tolerances by more than the allowable deviation of Table 401.02.27C then production shall be halted until the Contractor takes necessary steps to bring production under control. Production shall also be halted if three consecutive aggregate gradation tests fall outside the tolerance limits of Table 401.02.27B. Actions taken by the Contractor to bring production back in control shall be documented in the plant diary. Once production starts again, the moving average is reset.

7.2 When the four sample average of the Contractor's quality control tests for percent asphalt or percent air voids falls outside the JMF tolerances of Table 401.02.27C, the Sublot of material represented by the last individual test value in the moving average shall have its price reduced in accordance with the schedule set forth in Section 7.3. In the case where the average is nonconforming and the last tested Sublot is conforming, then there would be no price adjustment.

7.3 The degree of nonconformance shall be determined using the following relationship:

When the moving average is greater than the upper control limit

$Q_U = X_n - UL$

When the moving average is less than the lower control limit

$Q_L = LL - X_n$

Where Q_U = Percent of non-conformance at Upper Limit
Q_L = Percent of non-conformance at Lower Limit
UL = Upper Limit
LL = Lower Limit
X_n = Average of four consecutive test values (less than four when production is limited)

If it is decided by the Division that the material is to be allowed to remain in place, then the Sublot shall have its price reduced in accordance with Tables 401.02.27D and/or 401.02.27E as applicable.

TABLE 401.02.27D
ADJUSTMENT OF CONTRACT PRICE FOR MIX NOT WITHIN TOLERANCE LIMITS OF PERCENT ASPHALT

QU or QL	Percent of Contract Price to be Paid
0.0	100
0.1	98
0.2	96
0.3	92
Greater Than 0.3	*

* The Division will make a special evaluation of the material and determine the appropriate action.

TABLE 401.02.27E
ADJUSTMENT OF CONTRACT PRICE FOR MIX NOT WITHIN TOLERANCE LIMITS OF PERCENT AIR VOIDS

QU or QL	Percent of Contract Price to be Paid
0.0	100
0.1	98
0.2	96
0.3	92
Greater Than 0.3	*

* The Division will make a special evaluation of the material and determine the appropriate action.

7.4 Should the moving average of both the test properties for the same Sublot fall outside of the JMF tolerance, thus resulting in a reduced price for each, then the following procedure shall be used. The quantity of material represented by the last Sublot in the moving average will have an adjusted unit price which is the product of the original price times the percent as a result of non-conformance of the first test property times the percentage unit price as a result of non-conformance of the second test expressed in the following formula.

AUP = OUP x PUPAC x PUPAV *

Where: AUP = Adjusted Unit Price
OUP = Original Unit Price
PUPAC = Percent Unit Price as a result of Asphalt Content Analysis expressed as a decimal
PUPAV = Percent Unit Price as a result of Air Void Analysis expressed as a decimal

* PUPAC and PUPAV are used in the formula as needed as a single non-conforming item or together for both non-conforming items as shown.

7.5 A new moving average shall start with the fourth sample that is taken after production is resumed (less than four when production is limited). If, at any time, the Division determines that a mix cannot be consistently produced within the tolerance limits of the verified design properties, approval of the mix may be revoked and the contractor will be required to provide a new mix design.

8. SMALL QUANTITY TESTING

8.1 In the event that project activities are such that not more than 75 tons (70 Mg) of a specific mix design is being produced per day during the period of an entire calendar week, then the following small quantity testing requirements shall apply.

8.2 If the plant source rating is A-1, as determined per MP 700.00.52, Guide To Source Rating System Relative To Maintenance Contracts, then the minimum quality control sample requirements shall be one sample per week. The sample shall be taken on the first day of use during the week. If the plant source rating is A-2, as determined per MP 700.00.52, then the normal testing requirements of this MP shall apply.

9. DIVISION VERIFICATION SAMPLING AND TESTING

9.1 Verification sampling and testing is the responsibility of the Division. Quality control tests conducted by the Contractor may be used as a part of the verification process. Verification activities may be accomplished in any of three ways: 1) By conducting sampling and testing completely independent of the Quality Control activities, 2) by witnessing tests performed by the Contractor, or 3) by a combination of both the above. In all cases, those samples and tests taken by the Division completely independent of the Contractor will be taken at a frequency approximately equal to 10% of the frequency required in the Contractor's approved Quality Control Plan for the applicable item.

9.2 The verification samples taken by the Division will be statistically evaluated for similarity to the Contractors quality control tests in accordance with the guidelines set forth in MP 700.00.54. If the evaluation indicates that the Division’s test results are similar to the Contractor’s test results, then the material represented by this

evaluation will be considered acceptable. Those properties to be evaluated, as referenced in MP 700.00.54, will consist of percent asphalt, percent air voids, stability, flow, and gradations. In addition, the VMA test results will be evaluated using the guidelines of MP 700.00.54.

9.3 If a dissimilarity is detected, an immediate investigation will be conducted to determine the cause. The intent of the investigation is to define and correct any testing deficiencies that may cause a misrepresentation of the tested material.

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