CONTROL OF ASPHALT MIXTURES

1. SCOPE

This IM describes the Quality Control/Quality Assurance (QC/QA) procedures for monitoring and controlling plant-produced asphalt concrete mixtures on Quality Management of Asphalt (QMA) projects. Because the plant-produced mixtures may not develop test characteristics that meet design criteria, each mixture shall be evaluated during plant production. The evaluation procedures outlined herein are to be carefully followed so that all mix characteristics will conform to the appropriate requirements.

2. REFERENCE DOCUMENTS

Standard Specification 2303 Hot Mix Asphalt
AASHTO R 9-90 Acceptance Sampling Plans for Highway Construction
IM 204 Inspection of Construction Project Sampling & Testing
IM 208 Materials Laboratory Qualification Program
IM 216 Guidelines for Validating Test Results
IM 301 Aggregate Sampling & Minimum Size of Samples for Sieve Analysis
IM 302 Sieve Analysis of Aggregates
IM 320 Method of Sampling Compacted Asphalt Mixtures
IM 321 Method of Test for Compacted Density of Hot Mix Asphalt (HMA)(Displacement)
IM 322 Sampling Uncompacted Hot Mix Asphalt
IM 323 Method of Sampling Asphaltic Materials
IM 325 Compacting Asphalt Concrete by the Marshall Method
IM 325G Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
IM 336 Reducing Aggregate Field Samples to Test Samples
IM 337 Method to Determine Thickness of Completed Courses of Base, Subbase & Hot Mix Asphalt
IM 338 Method of Test to Determine Asphalt Binder Content & Gradation of Hot Mix Asphalt (HMA) by the Ignition Method
IM 350 Method of Test for Determining the Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
IM 357 Hot Mix Asphalt (HMA) Mix Sample for Test Specimens
IM 510 Method of Design of Hot Mix Asphalt Mixes

3. RESPONSIBILITIES

Appendix A contains an outline of the responsibilities required for all parties.

The Table of Responsibility, in Appendix A, is broken up into two main categories, Quality Action and Type of Project. The Type of Project is further broken down into two sub-categories, Certified Plant Inspection (CPI) and QMA, and projects with small quantities. The Quality Action is subdivided into the types of work needing to be performed. These areas are General, Asphalt Binder, Aggregate, Loose Hot Mix, Compacted Hot Mix and Revisions. The table is organized in a way to represent how the work would progress during a Hot Mix Asphalt paving operation.

Each Quality Action identifies the group responsible for ensuring the desired action is performed. The groups are the Contractor (CONTR), Resident Construction Office/Project Engineer (RCE), District Materials Office (DME), and the Central Materials Office (CTRL).

In accordance with IM 205, submit a Quality Control Plan to the Engineer prior to the preconstruction meeting. The plan shall include as a minimum items mentioned in Appendix D.

In addition, there are certain levels of certification required to perform specific activities. Depending on the Quality Action, an individual might be required to be a HMA Sampler, Level I HMA, Level II HMA, Level I AGG, or a Level II AGG Certified Technician.

4. SAMPLING & TESTING

Samples of the combined aggregate, asphalt binder, and plant-produced mixture are obtained in accordance with IM 204 and analyzed as soon as the operations of the plant stabilize.

Only the information obtained from random samples as directed and witnessed by the Engineer and validated by comparison to one or more of the paired samples tested by the Contracting Authority will be used for specification. Additional samples of aggregate and uncompacted asphalt mixture may be taken to provide better quality control. The results of testing done on additional samples will be for informational purposes only. Any proposed changes in the quality control and verification sampling/testing frequencies require the approval of the District Materials Engineer.

All testing done by the Contractor that is used as part of the acceptance decision shall be performed in qualified labs by certified technicians. On all QMA projects, the Level I HMA-Certified Technician is responsible for making sure that all samples are obtained according to the applicable IMs. Samples of uncompacted asphalt mixture and asphalt binder must be taken by someone with a minimum of a HMA Sampler Certification.

Retain samples taken for acceptance purposes until the lot has been accepted.

A. Asphalt Binder

Sample the asphalt binder in accordance with IM 323 at the frequency defined in IM 204. AASHTO procedures are used in the testing of asphalt binder.

B. Aggregate

1. Sample the aggregate randomly in accordance with IM 301 at the frequency defined in IM 204.
2. Test the aggregate in accordance with IM 336 and IM 302.
3. When results from one or more sieves of the specified gradation sample are outside the allowable gradation tolerances, the Engineer may direct and witness one additional aggregate sample or process one loose asphalt mixture sample to include in the gradation acceptance decision.

C.Uncompacted Asphalt Mixture

1. **Sampling**
   a. The specific ton or truckload to begin sampling will be determined by the Engineer using a random number system. Obtain production samples as directed and witnessed by the Engineer.
   b. Sample the uncompacted asphalt mixture in accordance with IM 322 at the frequency defined in Article 2303.03, D, 3, iii (or higher frequency pre-approved by the Engineer) quality control. Sample at the frequency defined in IM 204 for quality assurance.
2. **Testing**
   a. Test the uncompacted asphalt mixture in accordance with IM 357, IM 350, IM 325G, and IM 338.
   b. Compact two Gyratory specimens to the number of gyrations specified in the contract documents. The laboratory G_{mb} of each production sample will be determined by averaging the G_{mb} results of the compacted specimens.
   c. Laboratory voids, P_a, for each production sample will be determined from the results of laboratory G_{mb} and the corresponding individual Rice, G_{mm}, results.
   d. Calibrate the Rice pycnometer at the beginning of a project and anytime that a correlation problem occurs.
3. **Lot Size Determination**
   For PWL analysis of laboratory voids, lot size is defined as follows:
   a. No less than 8 and no more than 20 sequential tests will constitute a lot (exceptions stated below).
   b. After the 8th test, all subsequent samples collected over the remainder of that week will also be included in the lot up to a maximum of 20.
   c. Once a lot has been established with at least 8 tests, a new lot will begin at the start of the following week or the day following the 20th sample, whichever occurs first. Lots shall not contain partial days. When the 20th sample is reached, include all samples taken that day in the lot.
   d. When determining PWL lot size for lab voids, Sunday through Saturday defines a week.
   e. If the bid item's production has ended and fewer than 8 tests are available, those tests may be combined with the previous lot provided the maximum lot size has not already been reached. When combining results, if the day to be combined contains the 20th sample, include all samples for that day. Do not combine partial day's results.
   f. If samples cannot be combined with the previous lot due to maximum lot size restrictions or if fewer than 8 tests are available for the entire production of a bid item, combine those tests into a single lot and use the AAD analysis in IM 501.
   g. Test strips will be considered a separate lot.
   h. Use Table 2303.03-4 Uncompacted Mixture Sublot Size for determining sublots unless otherwise approved by the Engineer.

D. COMPACTED ASPHALT MIXTURE

1. **Sampling**
   a. Sample the compacted asphalt mixture in accordance with IM 320 at the frequency of 8 per day (or higher frequency pre-approved by the Engineer).
   b. The Engineer will provide inspection staff to direct and witness the sampling and perform G_{mb} measurement during a time agreed between the Engineer and the Contractor. The Engineer should make every effort to meet the Contractor's schedule.
   c. The Engineer will transport the cores in accordance with IM 320, or secure the cores for transport by the contractor. The Engineer and Contractor will determine that cores are not damaged. The Engineer will decide if a core is damaged prior to testing.
2. **Testing**
   a. Test the compacted asphalt mixture in accordance with IM 321 and IM 337.
   b. Field voids will be based on the average of at least 8 cores taken for each lot. Field voids will be determined using the average field G_{mb} result compared to the average maximum theoretical specific gravity, G_{mm}, obtained from samples, which correspond to the pavement from which the cores were taken.
   c. PWL will be calculated using the method described in IM 501. The upper and lower specification limits for field voids are 3.5% and 8.5% respectively. If the PWL results in less than 100% payment, the calculations to identify outliers will be performed. If the calculations identify an outlier with a Quality Index (QI) of at least 1.80, the outlier will be eliminated and a new PWL calculated with the remaining cores. The new PWL will be used to determine payment unless it results in a greater penalty. The Quality Index is based on AASHTO R 9-90. Examples on how to calculate PWL, QI and outliers are located in IM 501.
   d. Results must be determined and reported within the period of time specified.

3. **Lot Size Determination**
   A lot shall be considered as one layer of one mixture placed during a day's production.

5. VALIDATION

A. Defined

Validation is defined as the ability of two labs to achieve similar (statistically equivalent) test values on split or paired samples (split for aggregate samples and paired for asphalt concrete samples).

B. Aggregate Gradation Correction Factor

When comparing the cold-feed gradation to the ignition oven extracted gradation, a correction factor to adjust the extracted gradation must be determined in accordance with IM 501. Validation of the cold-feed gradation will be determined by comparing the cold-feed gradation and the corrected extracted gradation as shown on the comparison report for Cold-Feed & Ignition Oven in Material I.M. 216 Appendix A. The correction factors will be established by comparing an Agency cold-feed sample to an Agency ignition oven extracted sample.

C. Validation Requirements

1. When any of the following events occur, validation has not been achieved or maintained:
    a. The difference between test results on each of two consecutive split/paired samples exceeds the IM 216 tolerance.
    b. The difference between test results on any two of three consecutive split/paired samples exceeds the IM 216 tolerance.
    c. The test results in a series of split/paired samples (minimum of 3 samples, normally no more than 5) are not variable and random (results are consistently higher or results are consistently lower) and the difference between each split/paired test result is greater than half of the IM 216 tolerance.
2. Consecutive samples may be either validation samples tested sequentially with another lab or mix specific samples when other mixes are being tested for validation between the two labs. It may be necessary to examine validation of test results on consecutive samples **of the same mix** if more than one mix is being tested between the two labs. Validation problems sometimes only occur during testing of specific mix samples.
3. When validation for a particular test has not been achieved, all results for that day are considered invalid for that test.
4. To achieve or reestablish validation, a minimum of two consecutive test results must meet IM 216 tolerances, or when previous split/paired sample results were not variable and random, be within half of the IM 216 tolerances.

6. DISPUTE RESOLUTION

A. Investigation

When validation is not achieved or maintained, the District Materials Engineer may apply the following actions as appropriate to resolve split/paired test result differences. The DME shall report the results of the investigation to the Contractor.

1. Retest the same sample
2. The District labs will test additional verification samples.
3. The District Materials Engineer will review the sampling and testing procedures of both labs
4. The District Materials Engineer will immediately test samples sent in by the Contractor without allowing cool down and reheating (hot-to-hot testing).
5. Both labs will test samples using comparable reheat periods.
6. The District Materials Engineer will establish a correction factor based on the reheat evaluation outlined in Appendix B.
7. Both labs will test a sample that was taken and split by the Engineer.
8. Both labs and a third laboratory designated by the Contracting Authority will test a sample split three ways. The 3rd lab for state projects will normally be the Central Materials Lab.
9. The District Materials Engineer will establish a correction factor for the Contractor's gyratory compactor based on the procedure described in Appendix C. The correction factor for G_{mb} should not exceed 0.030.

B. Quality Assurance Protocol
  1. Resolution decisions by the Iowa DOT Central Materials Laboratory will be final.
  2. During the period of production when validation cannot be achieved, the Engineer's test results will be used for acceptance of the lot. Except in the case of Appendix A, 5, C, 1, c, the use of the Engineer's test values for acceptance will be retroactive to the time when the first sample exceeded the validation tolerance. Similarly, when validation is regained, the use of the Contractor's test results for acceptance is retroactive to the first test used to reestablish validation.
     a. Over the period which validation cannot be achieved for aggregate gradation, the Engineer's test results will be used for the entire gradation and applied to any calculations involving the gradation for the entire lot.
     b. If validation cannot be achieved between the ignition oven extracted gradation and the Contractor's cold-feed gradation, the Agency will run cold-feed gradations for validation in place of the ignition oven.
     c. Over the period which validation cannot be achieved on-uncompacted asphalt mixture tests for G_{mm} or G_{mb}, the Engineer's test results will be used as follows:
        i. For lots under the PWL acceptance plan,
           a) The Engineer's results and any other valid contractor's results for the lot will be used in the calculations for average field voids and average lab voids.
           b) If an F-test shows the variance of the Contractor's results for the lot is significantly different (α=0.05) than that of the Engineer's results, and the Engineer's sample size is greater than 3, the Engineer's results will replace all results used in standard deviation calculations for the lot. If not, the Contractor's results will be used in standard deviation calculations for lab voids regardless of whether or not validation is achieved.
        ii. For all other lots, the Engineer's results will be used for any calculations involving that particular test value.
        iii. Use a maximum pay factor of 1.000 for lab voids and field voids when the Engineer's results are used.
  3. The following tables illustrate an example for implementing the dispute resolution QA protocol. In this example, the Contractor's G_{mb} is invalid on 7/13, 7/15, and 7/16. The Contractor's G_{mm} is invalid on 7/8 and 7/9. Therefore the Engineer's results are used effective on the first day of noncompliance until Article 2303 Appendix A, 5, C, 4 is satisfied.

			Gmb					Gmm				
Day	Lot	Test No.	Cntrct	Owner	Diff	Meet IM 216?	Prevailing Result	Cntrct	Owner	Diff	Meet IM 216?	Prevailing Result
7/8	1	1	2.494	2.499	0.005	Yes	2.494	2.589				
7/8	1	2	2.492				2.492	2.580	2.591	0.011	No	2.591
7/8	1	3	2.487				2.487	2.592				
7/9	1	4	2.478				2.478	2.597				
7/9	1	5	2.499	2.498	0.001	Yes	2.499	2.595	2.606	0.011	No	2.606
7/9	1	6	2.491				2.491	2.586				
7/9	1	7	2.504				2.504	2.583				
7/12	1	8	2.502				2.502	2.567				2.567
7/12	1	9	2.505	2.497	0.008	Yes	2.505	2.580	2.575	0.005	Yes	2.580
7/12	1	10	2.503				2.503	2.580				2.580
7/13	1	11	2.478					2.601				2.601
7/13	1	12	2.480					2.587				2.587
7/13	1	13	2.468	2.489	0.021	No	2.489	2.592	2.590	0.002	Yes	2.592
7/13	1	14	2.476					2.580				2.580
7/14	1	15	2.412					2.583				2.583
7/14	1	16	2.470					2.593				2.593
7/14	1	17	2.484	2.483	0.001	Yes	2.483	2.587	2.580	0.007	Yes	2.587
7/15	1	18	2.461	2.482	0.021	No	2.482	2.581	2.582	0.001	Yes	2.581
7/15	1	19	2.461					2.585				2.585
7/15	1	20	2.471					2.591				2.591
7/16	2	21	2.466	2.487	0.021	No	2.487	2.587	2.590	0.003	Yes	2.587
7/16	2	22	2.484					2.587				2.587
7/16	2	23	2.479					2.594				2.594
7/19	2	24	2.470	2.461	0.009	Yes	2.470	2.584	2.578	0.006	Yes	2.584

The air voids are then calculated using the valid results. For days where the Contractor's G_{mm} was valid, but the G_{mb} was not, the air voids were calculated for each test using the Engineer's G_{mb} for that day and Contractor G_{mm} for that test. The same applies when G_{mb} is valid and G_{mm} is not. Voids are also calculated using just Contractor results and just the Engineer's results for further analysis of variability.

			Lab Voids		
Day	Lot	Test No.	Validated Results	Contractor	Owner
7/8	1	1	3.7	3.7	3.6
7/8	1	2	3.8	3.4	
7/8	1	3	4.0	4.1	
7/9	1	4	4.9	4.6	
7/9	1	5	4.1	3.7	4.1
7/9	1	6	4.4	3.7	
7/9	1	7	3.9	3.1	
7/12	1	8	2.5	2.5	
7/12	1	9	2.9	2.9	3.0
7/12	1	10	3.0	3.0	
7/13	1	11	4.3	4.7	
7/13	1	12	3.8	4.1	
7/13	1	13	4.0	4.8	3.9
7/13	1	14	3.5	4.0	
7/14	1	15	3.9	6.6	
7/14	1	16	4.2	4.7	
7/14	1	17	4.0	4.0	3.8
7/15	1	18	3.8	4.6	3.9
7/15	1	19	4.0	4.8	
7/15	1	20	4.2	4.6	
7/16	2	21	3.9	4.7	4.0
7/16	2	22	3.9	4.0	
7/16	2	23	4.1	4.4	
7/19	2	24	4.4	4.4	4.5

Because the owner has more than 3 test results, an F-test determines which standard deviation to use (Contractor's or Engineer's) in the PWL calculation. Since the F-test p-value is greater than 0.05, the variances are not considered significantly different and the Contractor's standard deviation is used. F-test is calculated in excel as "=FTEST(Contractor's air voids range, Owner's air voids range).

Lot 1 Stdev (contractor)	0.922
Lot 1 Stdev (owner)	0.385
Lot 1 F-test (p-value)	0.06

The validated results are used to calculate the average field voids as shown:

Avg	3.8
Stdev	0.922
Qil	0.916
Qiu	1.252
PWL	71.7

The PWL for Lot 1 is 71.7. Because the Engineer's results were used to calculate the average (and/or standard deviation) for lab voids, the maximum pay factor is 1.00. The G_{mm} used for Field Void calculations also only considers valid results for the lot. The average G_{mm} for valid results is 2.587 for Lot 1.

This example also illustrates when to begin a new lot. The first lot began on Thursday, 7/9/09. Since only 7 tests were run that week (Sun-Sat defines week), the lot carries over to the following week. The 8^{th} test was run on 7/12/09 (Sunday), so the lot includes all tests for the remainder of that week until either the 20^{th} test is reached or Saturday 7/18/09 is reached, whichever comes first. The 20^{th} test was reached on 7/15/09 so the next lot begins on the first test of the following working day (7/16/09). Had more tests been run on 7/15/09 all tests that day would have been included in the lot even though the total lot size would exceed 20. Lots are not divided in the middle of a working day.

7. PRODUCTION TOLERANCES

Production tolerances are listed in the specifications.

Investigate variations between two consecutive test results in G_{mb} or G_{mm} of more than 0.030 promptly since these tests reflect significant changes in binder content, aggregate properties and/or gradation. In some cases variations may be attributed to segregation, thoroughness of mixing, sampling procedure, and changes in aggregate production.

8. REPORTING

For each production sample of loose asphalt mixture the Contractor will determine, report, and plot (per QMA specification), G_{mb}, G_{mm} and P_a. Binder content measurement by an approved method will be determined, reported, and plotted daily. Gradation will be determined, reported and plotted daily. Make the inter lab correlation reports available.

Test results are to be recorded and plotted in the computer programs provided by the Iowa DOT. Copies of the completed Daily HMA Plant Report (Form #800241) summarizing all test results including the field density QI shall be provided to the District Materials Engineer and the Engineer within 4 hours of beginning operations on the next working day. Copies of computer files containing the project information shall be furnished to the Engineer on a CD upon project completion. An additional copy of the files shall be furnished to the DME on a CD.

9. ADJUSTING (TROUBLESHOOTING)

As stated in Article 2303.01, "The Contractor shall be responsible for all aspects of the project, provide Quality Control management and testing, and maintain the quality characteristics specified".

The Contractor is responsible for making changes, as necessary, to achieve target values specified on the JMF. These changes can include adjusting the proportions of aggregate and asphalt binder necessary to meet the JMF. If a change in the target gradation is desired, obtain approval of a new JMF from the District Materials Engineer. Changes in the target gradation cannot be set outside of the control points. The Contractor may change the target binder content to maintain the required mixture characteristics, provided the appropriate documentation and reporting is performed. Report all changes in proportions on the Daily HMA Plant Report (Form #800241).

The addition of new materials to the JMF may be approved by the District Materials Engineer without laboratory tests if the materials are produced from geologically comparable sources, do not constitute more than 15 % of the total aggregate, meet quality requirements, and produce mixes that meet design criteria. When aggregates are introduced from sources that are not geologically comparable or otherwise differ significantly, complete laboratory mix design testing and approval is required.

A polymer modified binder may be substituted into the JMF provided the original PG grade and temperature spread is met or exceeded. In this case, verify the JMF target air voids are met at the design binder content. If the substitution results in a G_{mb} change of more than 0.02, or more than 0.2% deviation from the target air void content, then complete laboratory mix design testing and approval is required. If the original JMF required moisture susceptibility testing and has consistently demonstrated acceptable TSR values in the field, the original anti-strip agent (if needed) and dosage rate may be used in lieu of IM 507 re-evaluation. Plant produced mix will still be tested for moisture susceptibility.

When a stockpile of recycled asphalt materials (RAM) has been depleted and constitutes less than 15% of the JMF, it may be substituted by another source of equivalent classification (Certified, Classified, Unclassified) to finish the project. In this case, update the JMF by entering the new RAM binder content, specific gravity, and absorption into SHADES. Verify the JMF remains compliant and test a lab compacted sample to show target air voids are met at the design binder content.

Moving averages and the gyratory compaction slope assist in identifying potential problems before they arise. Watch the trends in the moving averages (approaching a specification limit) and the slope of the compaction curve. The slope of the compaction curve of plant-produced material shall be monitored and variations in excess of ± 0.40 of the mixture design gyratory compaction curve slope may indicate potential problems with uniformity of the mixture.

10. GUIDANCE TABLES

The tables below are intended to provide guidance on dealing with the most common problems, which arise during the production of asphalt concrete mixture. The first table deals with problems, which can show up in the laboratory setting and the second table deals with problems, which can appear in the field.

The following example explains how to read the tables. Both tables are read downward. The shaded regions are the items to be considered for adjusting purposes.

Lab Problem Table

The first step is to identify which lab problem is occurring. If “Low Voids” is the identified problem, move down the column to the “Step 1 Check”. Assuming the first check is to be made on the “Binder Content”, move down the column to “Step 2 If”. If the Binder Content is high proceed to “Step 3 Verify”. Each of the shaded items identified in the “Step 3 Verify” should be looked at before proceeding further. Assuming that the items in “Step 3 Verify” are on target, go to “Step 4 Do”. In this case, the action to be taken in “Step 4 Do” is to “Lower Binder” in the mix. In all cases, the items in the “Step 3 Verify” are assumed to be within the allowable tolerances and won’t fall outside of allowable tolerances if the action in “Step 4 Do” is taken.

LAB PROBLEM		Low Voids			High Voids			Low Film Thickness			High Film Thickness			Low VMA			Hi
Step 1-Check	Binder Content	■			■			■			■						
	Gradation		■			■			■			■		■	■		■
	Aggr. SG (Gsb)			■			■									■	
	Aggr. Absorption									■			■				
Step 2-If	Low Binder				■			■									
	High Binder	■									■						
	Low -200					■						■					■
	High -200		■						■					■			
	Off JMF Target			■			■			■			■		■	■	
Step 3-Verify	Filler Bitumen Ratio	■	■		■	■		■	■		■	■		■	■		■
	Film Thickness	■	■		■	■								■	■		■
	VMA	■	■		■	■											
	Field Compaction	■	■			■		■	■	■	■	■	■				
	Voids							■	■		■	■		■	■		■
	Individual Aggr. Sources			■			■			■			■			■	
Step 4-Do	Lower Binder	■									■						
	Increase Binder				■			■									
	Lower -200		■						■					■			
	Increase -200					■						■					■
	Adjust Aggr. Proportions		■	■		■	■		■	■		■	■	■	■	■	■
	Recompute Volumetrics			■			■			■			■			■	

Field Problem Table

The first step is to identify which field problem is occurring. If “High Field Voids” is the identified problem, move down the column to the “Step 1 Check”. Assuming the first check is to be made on the “Lab Voids”, move down the column to “Step 2 If”. If the Lab Voids are high proceed to “Step 3 Verify”. Each of the shaded items identified in the “Step 3 Verify” should be looked at before proceeding further. Assuming that the items in “Step 3 Verify” are on target, go to “Step 4 Do”. In this case the process of looking at the “Step 3 Verify” would lead to the Lab Problem Table and cause one of the actions for High Lab Voids to be used.

In all cases, the items in the “Step 3 Verify” are assumed to be within allowable tolerances and won’t fall outside of allowable tolerances if the action in “Step 4 Do” is taken.

	FIELD PROBLEM	Low Field Voids		High Field Voids		Tender Mix				Low Density Q.I.		Agglomerates	Uncoated Aggr.		Brown Rock			Stripping
Step 1-Check	Stockpiles											■						
	Aggr. Absorption														■			
	Binder Content												■			■		
	Lab Voids	■		■		■				■								
	Film Thickness						■											
	Mixing Time													■				
	Moisture in Mix							■										■
	Mix Temp at Plant		■		■												■	
	Mat Temp								■		■							
Step 2-If	Low	■			■	■					■		■	■		■		
	High		■	■			■		■						■		■	
	Yes							■				■						■
Step 3-Verify	Filler/Bitumen Ratio												■			■		
	Film Thickness												■			■		
	Voids												■			■		
	Field Compaction																■	
	Aggr. Breakdown		■		■													
	Individual Aggr. Sources		■		■										■			
	Moisture		■		■												■	
	Amount of Clay Binder											■						
	Go To Lab Problem Table	■		■		■	■			■								
Step 4-	Increase Binder												■			■		
	Lower Temp		■						■								■	
	Increase Temp				■						■							

	Cover Loads																	
	Increase Aggr. Dryer Time																	
	Screen																	
	Adjust Aggr. Proportions																	
	Increase Wet Mixing Time																	