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CHAPTER SIX:

QUALITY CONTROL PROCEDURES

The foundation for a successful Quality Assurance program is the quality control maintained by the Producer to assure that all materials submitted for acceptance conform to the contract requirements. To accomplish this, the Producer is required to have a functional plan to keep the process in control, quickly determine when the process goes out of control, and respond adequately to bring the process back into control.

This section includes the minimum requirements of the Indiana Certified Hot Mix Asphalt Producer Program (Program) in accordance with **ITM 583**. The mixtures included in this Program include QC/QA HMA in accordance with Section **401**, HMA in accordance with Section **402**, and Stone Matrix Asphalt (SMA) in accordance with Section **410**.

PRODUCER PERSONNEL

The Producer personnel required include a Management Representative and a Certified Asphalt Technician.

Management Representative

The Management Representative is responsible for all aspects of production and control required by the Certified Hot Mix Asphalt Producer Program at each Certified Plant.

Certified Asphalt Technicians

A Certified Asphalt Technician is a Producer or Consultant employee who has been certified by INDOT. The Certified Asphalt Technician compacts and determines the bulk specific gravity of the Superpave gyratory specimens and conducts the maximum specific gravity test. The Technician supervises all other sampling and testing of materials, the maintenance of control charts, and the maintenance of the diary.

Qualified Technicians

All sampling and testing used for acceptance of materials is required to be conducted by a Qualified Technician. A Qualified Technician is an individual who has successfully completed the written and proficiency testing requirements of the INDOT Qualified Laboratory and Technician Program. Certified Asphalt Technicians are not required to take the written exam of this Program.

REFERENCE PUBLICATIONS

Each laboratory is required to have the following current documents on file:

- 1) Indiana Department of Transportation Standard Specifications (Includes applicable Special Provisions)
- 2) Indiana Hot Mix Asphalt Quality Assurance Certified Technician Program Manual
- 3) All applicable INDOT, AASHTO, and ASTM Test Methods
- 4) Testing equipment calibrations or verifications
- 5) Mix design, DMF or JMF for each mixture
- 6) Fines correction data for each DMF and JMF, if applicable
- 7) Process control test results
- 8) Type D certifications issued to active Department contracts
- 9) Type A certifications for PG 58-28 and PG 64-22 binder materials
- 10) PG 64-28 and PG 70-22 binder test reports from an AASHTO accredited laboratory whenever PG 58-28 and PG 64-22 are in-line blended with SBR polymer latex
- 11) Type A certifications for the SBR polymer latex

Each Certified Plant is required to have these current documents:

- 1) The Quality Control Plan (QCP) for the Certified Plant
- 2) Bill of lading of the binder from an Approved Supplier Certification Producer for the most current date of shipment
- 3) Weigh tickets from most current date of production
- 4) Instructions from the manufacturer concerning storage and handling of the binder
- 5) Flow meter calibration reports and flow computer printouts whenever in-line blending with SBR polymer latex

- 6) IDEM Legitimate Use Approval letter from the post-consumer asphalt shingle processing company
- 7) Plant calibrations for each DMF
- 8) Daily diary
- 7) Annual calibrations of the Plant scales and verification of meters
- 8) SMA stabilizing additive certification from the manufacturer
- 9) Instructions from the manufacturer concerning storage and handling of stabilizing additives

FIELD LABORATORY

A laboratory is required to be provided and maintained at the plant site with the necessary equipment and supplies for conducting quality control testing. An electronic balance readable to 0.1g and accurate to 0.2g or 0.1% of the test load, whichever is greater, is required. Also, the gyratory compactor is required to tilt the specimen mold at an internal angle of $1.16 \pm 0.02^\circ$ in accordance with **AASHTO T 344**.

Performance of quality control tests at laboratory facilities other than the plant-site laboratory are allowed provided the laboratory facilities are owned by the Producer, all test procedure criteria are satisfied, and the test results are furnished in writing to the plant-site laboratory within two working days. INDOT is allowed access to inspect any laboratory used for quality control testing and to witness quality control activities.

TEST EQUIPMENT CALIBRATION

The equipment furnished for testing is required to be properly calibrated and maintained within the calibration limits described in the applicable test method. A record of calibration results is maintained at the field laboratory for the equipment listed in the following table:

| Equipment | Requirement | Min Freq | Procedure |
|------------------------------------|-----------------------------|-----------------|------------------|
| Balances | Verification | 12 mo. | ITM 910 |
| Gyratory Compactor | Verification | 1 mo. | ITM 908 |
| Gyratory Compactor Internal Angle | Verification | 12 mo. | AASHTO T 344 |
| Gyratory Mold and Plate Dimensions | Verification | 12 mo. | AASHTO T 312 |
| Ignition Oven | Conduct Lift Test | Weekly | Operators Manual |
| Mechanical Shakers | Verify Sieving Thoroughness | 12 mo. | ITM 906 |
| Ovens | Verify Temp. Settings | 12 mo. | ITM 903 |
| Sieves | Verify Physical Condition | 12 mo. | ITM 902 |
| Thermometers | Verification | 12 mo. | ITM 909 |
| Vacuum Pump | Verify Pressure | 12 mo. | ITM 905 |
| Vacuum Chamber | Verification | 3 mo. | ITM 905 |

The equipment used to calibrate or verify the testing equipment is required to be NIST traceable and calibrated in accordance with the following frequencies:

| Calibration Equipment | Testing Equipment | Minimum Frequency |
|---|---|--------------------------|
| Bore Gauge | Gyratory Compactor Molds – AASHTO T 312 | 12 mo. |
| Dynamometer or Load Cell & Proving Ring | Gyratory Compactor – AASHTO T 312 | 24 mo. |
| Height Gage Blocks | Gyratory Compactor – AASHTO T 312 | 24 mo. |
| Height Billet | Gyratory Compactor – AASHTO T 312 | 24 mo. |
| Vacuum Gage | Vacuum Systems – ITM 905 Vacuum Flask – AASHTO T 209 | 36 mo. |
| Weights, Min. Class 3 | Balances – ITM 910 | 12 mo. |

DIARY

The Producer is required to maintain a diary at the Certified Plant. The diary is an open format book with at least one page devoted to each day mixture is produced. The diary is kept on file for a minimum period of three years.

Entries in the diary include at least the following:

- 1) The quantity of mixture produced, DMF or JMF, and the contract number or purchase order for each mixture
- 2) The time that the samples were obtained and the time the test was completed
- 3) Nonconforming tests and the resulting corrective action taken
- 4) Any significant events or problems
- 5) Warm Mix Asphalt
 - a) Daily weather conditions, production rates and mixture discharge temperature ranges
 - b) Observations on aggregate coatings at discharge
 - c) Observations on plant and bag-house performance
 - d) Observations on plant fuel consumption
 - e) Observations on silo storage times
 - f) Haul distance and times
 - g) Delivery temperature at paver

The diary entry is to be routinely signed by the Certified Asphalt Technician or Management Representative. On occasion the diary may be signed by another person; however, the diary is required to be counter-signed by the Certified Asphalt Technician or Management Representative.

MATERIAL SAMPLING

The Producer is required to designate the sampling and sample reduction procedures, sampling location, and size of samples necessary for testing. Sampling is conducted on uniform tonnage increments on a random basis.

AGGREGATE/RAP SAMPLING

Aggregate samples may be obtained from stockpiles, belts, or hot bins depending on the type of plant and control of aggregate gradation selected. The procedures for these methods of sampling are described in Chapter 2. If RAP is used in the mixture, the procedure for sampling this material is **ITM 207**.

BINDER SAMPLING

Two one quart samples are obtained from either the Certified Plant binder tank or injection line in accordance with **AASHTO T 40**. The procedure for sampling binder is described in Chapter 3.

MIXTURE SAMPLING

The most important consideration in sampling mixture is to be certain that the sample taken is representative of the material being produced. The sampling procedures for mixture are included in **ITM 580**. For truck sampling, a square bit shovel of the appropriate size for the required sample is used. For plate sampling, a metal square plate with a minimum size of 8 in. is used. Procedures for truck sampling and pavement sampling are explained as follows:

Truck Sampling – 4.75 mm Mixtures

- 1) The mixture in the truck is visually observed for determination of uniformity.
- 2) The shovel is inserted into the the mixture at various locations that appear uniform in texture, and the mixture is placed into a sample container.

Truck Sampling -- Dense Graded Mixtures

- 1) The shovel is inserted horizontally into the mixture at the approximate mid section of the truck.
- 2) The shovel is lifted vertically to establish a horizontal plane in the mixture.
- 3) The shovel is inserted vertically to establish a vertical face below the horizontal plane.
- 4) The shovel is inserted horizontally into the vertical face at a depth of approximately twice the thickness of the maximum particle size of the material.
- 5) The shovel is lifted vertically to obtain the sample, and the sample is placed into a sample container.

Truck Sampling – Open Graded Mixtures

- 1) The shovel is inserted into the mixture between the center of the cone and the front of the truck to obtain one sample.
- 2) Another sample is obtained with the shovel from the mixture between the center of the truck and the back of the truck.
- 3) The two samples are combined.

Pavement Sampling -- Plate

- 1) A clean metal plate with attached wire is placed on the pavement. Should conditions on the contract require stabilizing movement to avoid slipping of the plate, a nail is driven into the pavement, and the plate hole placed onto the nail. A No. 18 gage mechanics wire and masonry nail has proven to be effective for this purpose.
- 2) The wire is extended beyond the edge of the paving width. The wire should not pass under a grade leveler attached to the paver. Trucks, pavers, or material transfer devices are allowed to cross the plate and/or wire. If a windrow elevator is used, the paving operation is stopped so that the plate may be placed between the windrow elevator and the paver.
- 3) After the mixture is placed and before any compaction from the rollers occurs, the wire is used to locate the plate.
- 4) The plate is lifted with the wire, a narrow shovel or pitchfork is inserted under the plate, and the plate is lifted from the pavement.
- 5) The sample is then placed in a container for transport to the testing facility. Material remaining on the plate is required to be removed and placed into the sample container.

Pavement Sampling -- Plate with a Mold

The placement and location of the plate are done using the same procedures and restrictions used for sampling when only a plate is used. Additional requirements for using a mold with a plate include:

- 1) A clean round mold, with a height greater than the mixture thickness and diameter less than the width of the plate, is pushed by means of a circular motion down into the mixture directly over the plate.
- 2) The mold and plate are raised together and a pitchfork or narrow shovel is inserted under the plate.
- 3) The mold and plate are lifted from the pavement and any excess mixture on top of the plate and outside of the mold is discarded.
- 4) The sample inside the mold is placed into the sample container. Material remaining on the plate is removed and placed into the sample container.

MIXTURE SAMPLE REDUCTION

Once the sample is obtained, the next step required is to reduce the sample to the appropriate test size. The sample reduction procedures are included in **ITM 587**. Sample reduction to meet a minimum weight, a weight range, and a target weight are as follows:

Minimum Weight -- Asphalt Mixture Extraction and Maximum Specific Gravity

- 1) The sample is placed on a clean splitting board and thoroughly mixed with a trowel or dry wall taping knife.
- 2) The sample is then quartered into four approximately equal portions, the diagonally opposite quarters are combined, and the sample weighed.
- 3) If the sample weight does not meet the minimum weight requirement of the appropriate test method, the sample is set aside and the remaining mixture is recombined, mixed, and quartered again.
- 4) The diagonally opposite quarters of the recombined mixture are added to the sample that was set aside. This procedure is repeated until the appropriate test size is obtained.
- 5) If the sample after combining the diagonally opposite quarters of the original sample is excessively large, the sample may be discarded. The remaining mixture is recombined and quartered, as indicated above, until the appropriate size of sample is obtained.

Weight Range -- Ignition Oven

The procedure for reducing a sample for testing using the ignition oven is different than the above procedure because the sample size is required to be within a weight range. The procedure is as follows:

- 1) The sample is placed on a clean splitting board and thoroughly mixed with a trowel or dry-wall taping knife.
- 2) The sample is then quartered into four approximately equal portions, the diagonally opposite quarters are combined, and the sample is weighed.
- 3) If the sample weight does not meet the minimum weight requirement for the ignition test, the sample is set aside, and the remaining mixture is recombined, mixed, and quartered again.

- 4) The diagonally opposite quarters of the recombined mixture are added to the sample that was set aside.
- 5) If the total sample weight is less than the required minimum weight, the quartering procedure is repeated with the remaining mixture until a proper weight is obtained.
- 6) If the sample, after combining the diagonally opposite quarters of the additional mixture to the original sample, exceeds the maximum weight requirement for the ignition test, the additional sample is discarded and the quartering procedure as noted above is continued for the remaining mixture until the proper weight is obtained.

Target Weight – Gyrotory Specimens

The procedure for reducing a sample to fabricate a specimen with the gyrotory compactor requires that an exact weight be obtained as designated on the DMF/JMF to obtain the correct height of the specimen. The procedure is as follows:

- 1) The sample is placed on a clean splitting board
- 2) The sample is thoroughly mixed with a trowel or dry-wall taping knife and quartered into four approximately equal portions
- 3) Two diagonally opposite portions are combined and the sample weighed (Note 1). This sample will initially be used to prepare Specimen A.

Note 1: The sample will generally exceed the target weight by more than 300 g after the first split. Weighing the sample is not required when the sample obviously exceeds the target weight. The remaining portions from the initial split are set aside for later use in Specimen B.

- 4) If the sample is greater than the target weight and not within 300 g of the target, steps 2 and 3 are repeated on the sample. When the sample becomes less than the target weight by more than 300 g, step 5 is done next. If the sample is within ± 300 g of the target weight, step 6 or 7 is used depending on whether the sample is less than or greater than the target weight.

- 5) If the sample is less than the target weight and not within 300 g of the target, the sample is set aside and steps 2 and 3 are repeated on the remaining portions. The diagonally opposite portions are added to the previously weighed sample until the sample is within ± 300 g of the target weight (Note 2). Step 6 or step 7 is done next.

Note 2: Exceeding the target weight by more than 300 g should be avoided. If in doubt, the diagonally opposite portions should be weighed prior to adding to the previously weighed sample to avoid exceeding the target weight. If the target weight has been exceeded by 300 g, the procedure should be started over.

- 6) For samples less than and within 300 g of the target weight, the remaining quarters are mixed into a miniature stockpile. An amount required for achieving the target weight is carefully added to the sample by sampling with a trowel at a location approximately one-third the stockpile height, measured from the base of the stockpile. The target weight is considered obtained when the weight is within ± 10 g of the DMF/JMF target weight value.
- 7) For samples more than and within 300 g of the target weight, the sample is mixed into a miniature stockpile. An amount required for achieving the target weight is carefully removed from the sample by sampling with a trowel at a location approximately one-third the stockpile height, measured from the base of the stockpile.
- 8) The remnant material from Specimen A is discarded and these procedures are repeated on material saved from the initial split for use in Specimen B.

MATERIALS TESTING

The Producer is required to designate the testing procedures to be used for control of the aggregates, RAP, and mixture. Testing is required to be completed within two working days of the time the sample was taken. The Producer is required to keep the test results on file for a minimum period of three years.

AGGREGATE TESTING

Gradation

Gradations done on blended aggregate or aggregate stockpile samples are conducted using **AASHTO T 27**. If RAP is used in the mixture, the test procedure for the gradation is **AASHTO T 30**.

Moisture Content

AASHTO T 255 is the test procedure used for determination of the total moisture content of the cold feed belt or belt discharge aggregate samples for a drum plant.

MIXTURE TESTING

The analysis of the mixture to meet the requirements of the Program includes several tests. Detailed procedures of these tests are included in appendices A and B and include:

Mixture Calibration

A plant calibration is required to be made for each mixture to be produced in accordance with the following methods:

Batch Plants -- the percentage of the total aggregate to be obtained from each hot bin and the RAP belt

Drum Plants -- the percentage of the total aggregate to be obtained from each cold bin and the RAP bin

Moisture Content

ITM 572 outlines the procedure for determination of the moisture content. Of particular importance is that the sample be placed immediately into an oven bag when obtaining the sample so that an accurate moisture content may be obtained.

Binder Content

Several methods are allowed for determination of the binder content; however, the Ignition Method (**ITM 586**) and the Extraction Method (**ITM 571**) are the most common procedures.

Extracted Aggregate Gradation

After the binder content has been determined in accordance with **ITM 571**, the sieve analysis of the aggregate is made using **AASHTO T 30**, except the decantation through the No. 200 sieve is not required. If the Ignition Oven is used, the aggregate sample is first decanted and then the sample is sieved in accordance with **AASHTO T 30**.

Coarse Aggregate Angularity

If gravel is used in the mixture or the RAP contains gravel, the coarse aggregate angularity (crushed content) is determined after the sieve analysis. **ASTM D 5821** is the procedure used for determination of both one and two faced crushed particles.

Mixture Specimen Preparation

Specimens to determine the air voids and VMA are compacted to N_{des} in accordance with **AASHTO T 312**. The compaction temperature is $300 \pm 9^{\circ}\text{F}$ for dense graded mixtures and SMA, and $260 \pm 9^{\circ}\text{F}$ for open graded mixtures.

Bulk Specific Gravity

AASHTO T 166 is the procedure used for determination of the bulk specific gravity of the gyratory specimens for dense graded and SMA mixtures. The bulk specific gravity of the gyratory specimens for open graded mixtures, OG 19.0 and OG 25.0, is determined in accordance with **AASHTO T 331**.

Maximum Specific Gravity

AASHTO T 209 is the procedure used for determination of the maximum specific gravity of the mixture. The supplemental procedure for mixtures containing porous aggregates may be required if the aggregate absorbs water during the test.

Draindown

AASHTO T 305 is the procedure used to determine the amount of binder that drains from the mixture during production. This is a requirement for open graded mixtures and SMA.

Temperature

The best procedure to determine the temperature of the mixture is with a dial and armored-stem thermometer. The stem is required to be inserted sufficiently deep (at least 6 in.) into the mixture, and the material is required to be in direct contact with the stem.

The gun-type infrared thermal meter, which measures reflective heat from the surface, may also be used. This device detects only surface heat and may not be accurate for material within the truck. To overcome this problem, the instrument may be directed at the stream of mixture at the discharge gate of the mixer or surge bin.

FREQUENCY OF TESTS

QC/QA HMA and SMA

The frequency of tests is determined by the Producer and is required to be included in the QCP for the following items:

- 1) Aggregates
 - a) Stockpiles
 - b) Blended Aggregate
- 2) Binder
- 3) Recycled Materials
 - a) Binder Content
 - b) Gradation
 - c) Moisture Content
 - d) Coarse Aggregate Angularity
- 4) Mixture Sampled at the HMA plant
 - a) Binder Content
 - b) Gradation (for SMA mixtures only)
 - c) Moisture Content (HMA and WMA mixtures)
 1. WMA – each production subplot within the first lot
 2. WMA – each production day thereafter
 - d) Temperature
 - e) Draindown (for open graded and SMA mixtures only)
- 5) Mixture Sampled from the Pavement
 - a) Air Voids
 - b) VMA
 - c) Actual Binder Content
 - d) Gradation (for SMA mixtures only)
 - e) Moisture (for surface mixtures only)
 - f) Bulk Specific Gravity
 - g) Maximum Specific Gravity

HMA

HMA mixture produced concurrently with QC/QA HMA mixture is required to be sampled and tested in accordance with the requirements established for QC/QA HMA. All other HMA is required to be sampled at the HMA plant or the roadway and tested for binder content, coarse aggregate angularity for mixtures containing gravel, gradation, and air voids in accordance with the following minimum frequency:

- 1) The first 250 tons and each subsequent 1000 tons of each DMF or JMF in a construction season for base and intermediate mixtures
- 2) The first 250 tons and each subsequent 600 tons of each DMF or JMF in a construction season for surface mixtures

ADJUSTMENT PERIOD – QC/QA HMA and SMA

The Producer is allowed an adjustment period for each DMF in which changes may be made. The adjustment period is from the beginning of production and extending until 5000 tons of base and intermediate mixtures or 3000 tons of surface mixture has been produced. A reduced adjustment period may be allowed. A JMF is established after the adjustment period. The following adjustments are allowed:

- 1) The aggregate and recycled materials blend percentage and the amount passing all sieves on the DMF may be adjusted. The gradation limits may not exceed the requirements of Section **401.05** for QC/QA HMA mixtures and **410.05** for SMA mixtures, and the dust/calculated effective binder ratio may not exceed the requirements of Section **401.05**.
- 2) The total binder content on the JMF may be adjusted ± 0.5 percent provided the dust/calculated effective binder ratio is in accordance with Section **401.05**. The recycled materials binder content may be adjusted as part of the total binder content provided the binder replacement percentage is in accordance with Sections **401.06** and **410.06**.
- 3) The VMA on the JMF for QC/QA HMA may be adjusted provided the new value is in accordance with Section **401.05**.
- 4) The air voids and VMA for open graded mixtures may be adjusted from the DMF provided the new value is in accordance with Section **401.05**.

- 5) The gyratory specimen target weight on the JMF may be adjusted from the DMF to produce specimen heights of 115 ± 5 mm in accordance with **AASHTO T 312**.

If an adjustment is necessary, a JMF is submitted in writing for approval to the District Testing Engineer one working day after the receipt of the original test results for the binder content, VMA, and air voids of the adjustment period. The JMF is required to include the adjusted gradation, binder content or VMA, unit weight at N_{des} , and the dust/calculated effective binder ratio, if applicable.

Only one adjustment period is allowed for each DMF within a construction season. If production extends into the next construction season, the DMF is allowed another adjustment period. If a JMF was approved, the adjustments are made from the JMF.

CONTROL CHARTS

A control chart is a graphic representation of data shown with prescribed limits that indicate whether a process is in control. Although not required by the Certified HMA Producer Program, control charts may prevent the production of nonconforming material when used in a timely manner. An example of a control chart is shown in Figure 6-1.

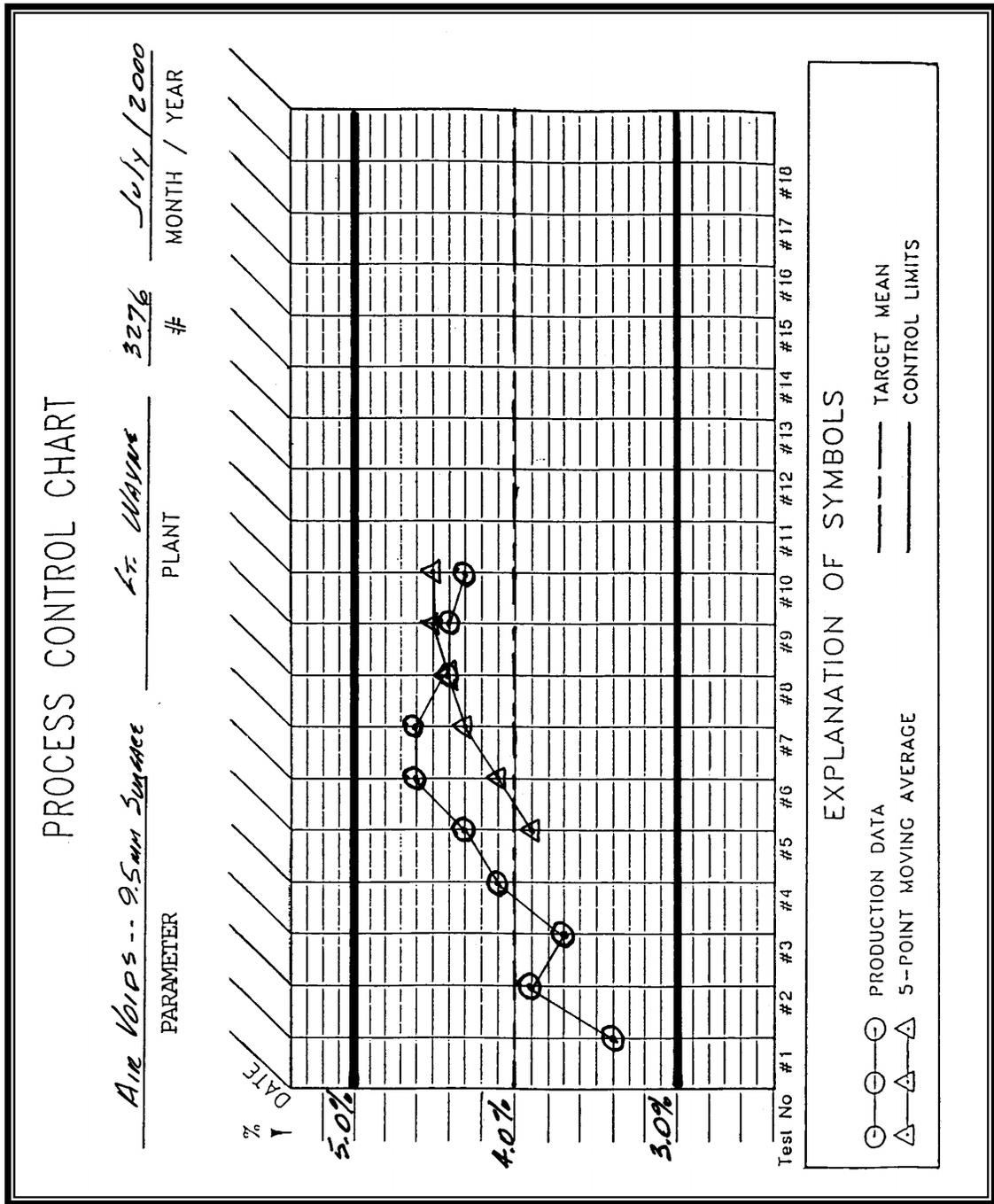


Figure 6-1. Control Chart

CONTROL LIMITS

The control limits from the the target mean value are as follows:

| Parameter | Control Limits |
|--|----------------|
| <u>Aggregate Stockpile Samples,</u> Max. % Passing Sieves | |
| 3/4 in. | ± 10.0 |
| 1/2 in. | ± 10.0 |
| No. 4 | ± 10.0 |
| No. 8 | ± 10.0 |
| No. 16 | ± 8.0 |
| No. 30 | ± 6.0 |
| No. 50 | ± 6.0 |
| No. 100 | ± 6.0 |
| No. 200 | ± 2.0 |
| <u>Blended Aggregate, Max. % Passing Sieve</u> Base and Intermediate Mixtures | |
| 3/4 in. | ± 10.0 |
| 1/2 in. | ± 10.0 |
| No. 4 | ± 10.0 |
| No. 8 | ± 10.0 |
| No. 16 | ± 8.0 |
| No. 30 | ± 6.0 |
| No. 50 | ± 6.0 |
| No. 100 | ± 6.0 |
| No. 200 | ± 2.0 |
| <u>Blended Aggregate, Max. % Passing Sieve</u> Surface Mixtures | |
| 1/2 in. | ± 10.0 |
| No. 4 | ± 10.0 |
| No. 8 | ± 8.0 |
| No. 16 | ± 8.0 |
| No. 30 | ± 4.0 |
| No. 50 | ± 4.0 |
| No. 100 | ± 3.0 |
| No. 200 | ± 2.0 |
| Binder Content of Mixture, % | ± 0.7 |
| VMA @ N _{des} , % (QC/QA HMA) | ± 1.0 |
| VMA @ N ₁₀₀ , Min. % (SMA) | 17 |
| Air Voids @ N _{des} , % (Dense Graded Mixtures and SMA) | ± 1.0 |
| Air Voids, % (Open Graded Mixtures) | ± 3.0 |

Figure 6-2. Control Limits

TARGET MEAN VALUES

The target mean values are required to be as follows:

Binder Content -- the value indicated on the JMF

Air Voids -- the value designated by the Producer

Voids in Mineral Aggregate -- the value indicated on the JMF

CONTROL CHART CONSTRUCTION

The control chart should have a means of designating the target mean, control limits, individual test results, and a moving average of the test results. One example of designating these values on the chart is as follows:

- 1) The target mean value is represented by a heavy long dash followed by a short dash line
- 2) Control limits are represented by heavy solid lines
- 3) The placement of the horizontal lines for the control limits and target mean value are numerically identified in the left margin
- 4) The plot point for the test results is surrounded by a small circle and each consecutive point is connected by a solid straight line
- 5) The moving average of the most current test values is indicated by a small triangle symbol and connected by straight lines
- 6) The test results are plotted left to right in chronological order and dates corresponding to each test are shown along the horizontal axis
- 7) All values are plotted to the nearest 0.1 percent

Test results for samples obtained from other than at the Certified Plant may be plotted on the corresponding chart provided the points are not connected with the test results from the Certified Plant and the test results are not included in the moving average. An example of a control chart is shown in Figure 6-1.

CHART INTERPRETATION

The moving average is useful in determining the accuracy of the process. Averages tend to lessen the effect of erratic data points that may reflect errors not related to the actual material (sampling, testing, etc.). The presence of unusual patterns or trends may be evidence of nonconformance during the period of the pattern. Any of the following potential nonconforming conditions (Figure 6-3) concerning the moving average may be reason for an investigation of the process.

- 1) 7 or more points in a row are above or below the target mean
- 2) 7 or more points in a row are consistently increasing or decreasing

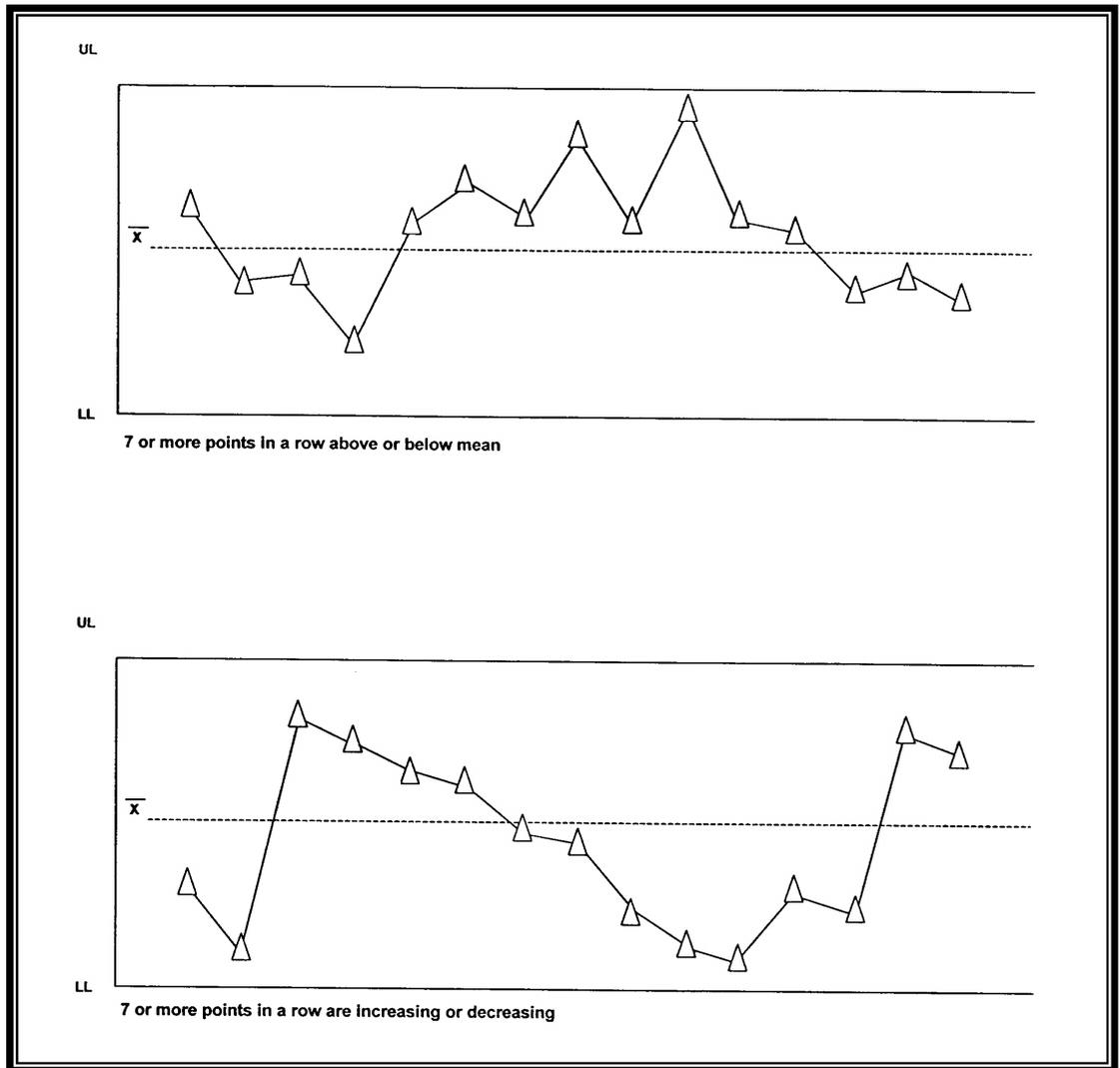


Figure 6-3. Moving Average Trends

RESPONSE TO TEST RESULTS

CONTROL LIMITS

The Producer is required to take corrective action when the control limits for QC/QA HMA and SMA or Specification Limits for HMA mixtures are exceeded for the appropriate properties of binder content of the mixture, air voids, and VMA. Corrective action includes, but is not limited to, investigation for assignable cause, correction of known assignable cause, or retesting.

MOISTURE CONTENT

The Producer is required to take corrective action when the moisture content of the mixture exceeds 0.30 percent for samples taken at the plant, or when the moisture content of the surface mixture sampled from the pavement exceeds 0.10 percent.

VOLUMETRIC CONTROL

Verification of the volumetric mixture properties is one of the most important duties of the Technician. Changes in the material or control at the HMA plant may result in the air voids and VMA falling outside of the Specification limits. The general trend is that the design air voids and VMA will decrease during production at the plant. This section contains information concerning the steps that may be taken to correct a deficient volumetric property. In order to use these guidelines, the mixture composition is required to be reasonably close to the designed mixture.

VMA

Figure 6-4 is a flow chart for VMA adjustment for plant - produced mixture. The amount of material passing the No. 200 sieve and the relative proportions of coarse and fine aggregate may significantly affect the VMA. A loss of VMA is a common problem during production.

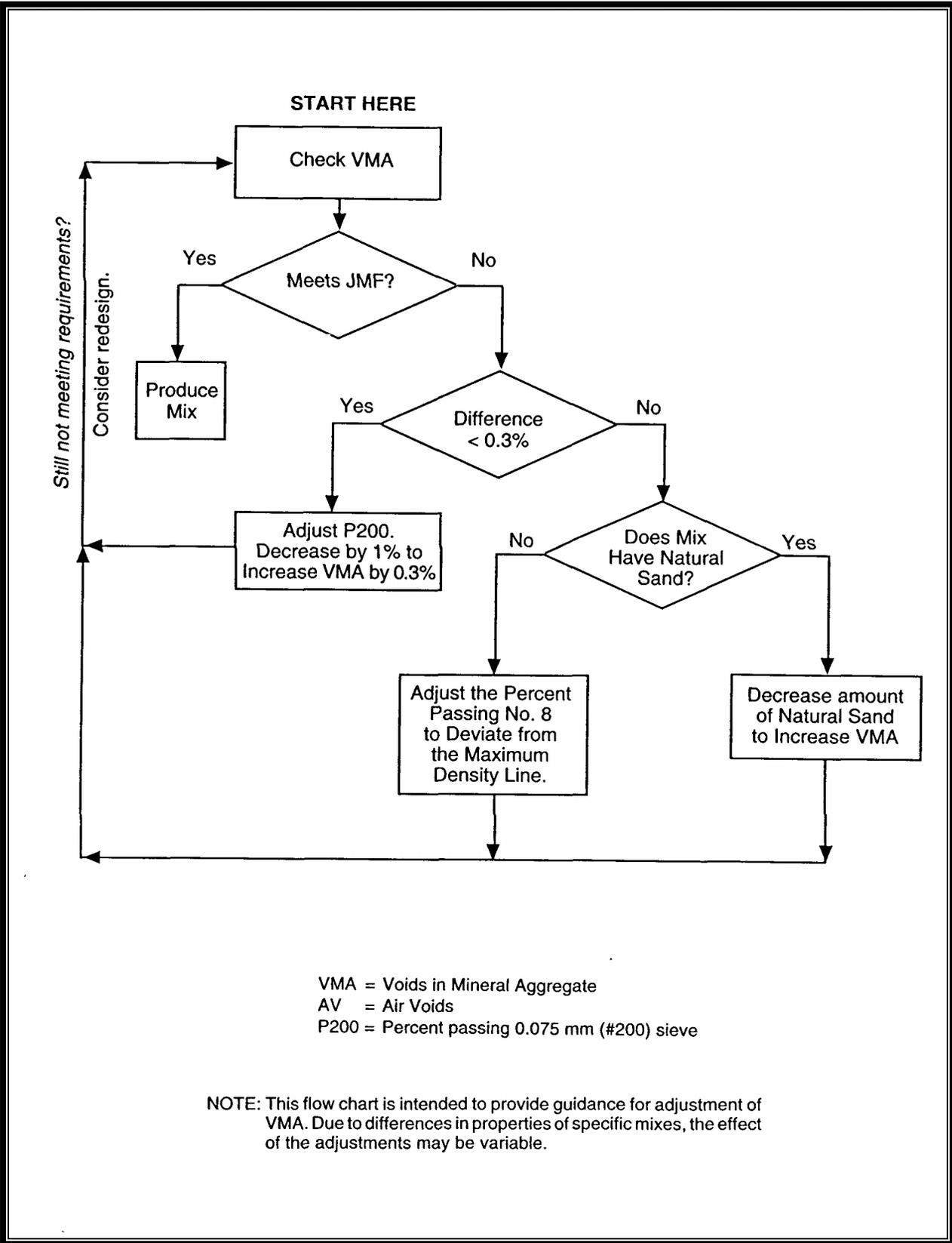


Figure 6-4. VMA Adjustment Process

Gradation changes may be caused by a mechanical problem with the plant. A comparison of the blended aggregate and extracted aggregate gradations is a good technique to verify if this problem exists. Also, there is, in most cases, some "rounding" of the edges of the coarse aggregate particles as they pass through the drum. This rounding of the aggregate lowers the VMA.

Dust variation in the mixture may be caused by variations in the minus No. 200 sieve material of the aggregates; however, a change in the dust is more likely to be the result of the inconsistent return of fines from the plant baghouse. Specifications require that if dust is returned into the mixture, the system is required to return the material at a constant rate during production. A check on the fines return system is required to be made to verify this constant rate of return of fines.

Adjusting for low VMA is the more common problem a Technician needs to correct. Procedures for increasing the VMA include:

- 1) Reduce the amount of material passing the No. 200 sieve
- 2) Reduce the amount of natural sand in the mixture
- 3) Adjust the aggregate gradation away from the Maximum Density Line

AIR VOIDS

Figure 6-5 is a flow chart for adjusting air voids for plant-produced mixture. Air voids are influenced by a combination of VMA, percent passing the No. 200 sieve, and the binder content. Adjustments of the air voids are dependent on the magnitude of the variance between the production and JMF values. If the difference is greater than 0.5 percent, consideration should be given to adjusting the binder content; if the difference is less than 0.5 percent, the percent passing the No. 200 sieve may be adjusted.

A comparison of the production bulk specific gravity (G_{mb}) and maximum specific gravity (G_{mm}) values to the DMF and previous production values should also be done. Different G_{mb} values may be caused by an aggregate gradation change (especially the P 200) or by a particle shape change from aggregate breakdown. Different G_{mm} values may be caused by a binder content, aggregate absorption, or aggregate specific gravity change.

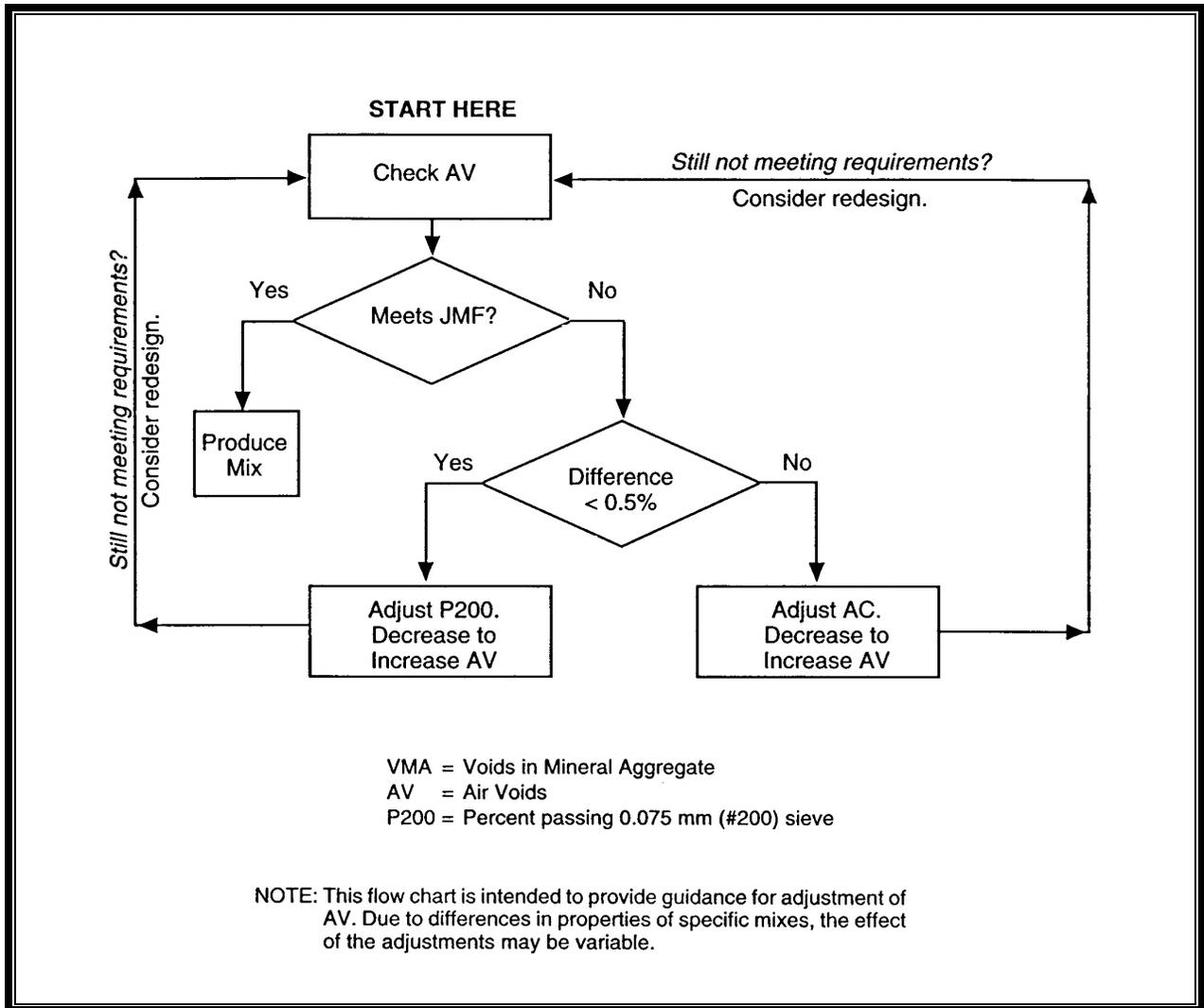


Figure 6-5. Air Voids Adjustment Process

The air voids, as with the VMA, may need to be increased in most cases when the Specifications are not being met. Procedures for increasing the air voids include:

- 1) Reduce the binder content
- 2) Reduce the amount passing the No. 200 sieve
- 3) Change the relative proportion of coarse and fine aggregate

MIXTURE TROUBLESHOOTING

Figure 6-6 lists the materials and properties that are verified at the HMA plant and the possible causes of problems with these materials. For each property, the potential problem areas are given a priority number with the number 1 being the area that should be checked first.

Verification of the mix design prior to production for the contract is the best procedure to prevent potential problems. By using the actual stockpiled materials and testing the effect the HMA plant has on those materials, adjustments may be made to the mixture to meet the requirements.

During production there are other means available to make a quick determination of the properties of the mixture. For volumetric determinations, the air voids and VMA may be approximated by estimating the bulk specific gravity (G_{mb}) of the mixture. This estimation of G_{mb} is made from the height of the gyratory specimen when a constant sample mass is used.

| | | AGG. STOCK- PILES | BLENDED AGG. GRADATION | MIX BINDER % | RAP BINDER % | AIR VOIDS | VMA |
|----|---|-------------------------|------------------------------|-----------------|-----------------|--------------|----------|
| | | Priority | Priority | Priority | Priority | Priority | Priority |
| 01 | Results / Sampling / Test Equipment: Verify | 1 | 1 | 1 | 1 | 1 | 1 |
| 02 | Stockpiles: Visually Check Segregation | 2 | 2 | | 2 | | |
| 03 | Loader Operations: Check | 3 | 3 | | 3 | | |
| 04 | Stockpiling & Trucking: Check | 4 | 4 | | | | |
| 05 | CAPP Source: Discuss Findings | 5 | 8 | | | | |
| 06 | Cold Feed – Loading | | 5 | | | | |
| 07 | Cold Feed – Contamination | | 6 | | | | |
| 08 | Cold Feed– Gates / Control Systems / Blend Percents | | 7 | | | | |
| 09 | Gradation vs. Binder %: Graph | | | 3 | 5 | | |
| | A. Mix: Segregation? | | | 3A | 5A | | |
| | B. Plant: Malfunction / Deterioration? | | | 3B | 5B | | |
| 10 | Plant Settings: Check | | | 2 | | | |
| 11 | Total Binder Consumption vs. Mix Production: Check | | | 5 | | | |
| 12 | RAP: Processed RAP / Uniformity/ Binder Content | | | 4 | 4 | | |
| 13 | Mix Gradation: Check | | | | | 3 | 2 |
| 14 | Mix Agg. Blend of Components (Particle Shape Issues): Check | | | | | 4 | 4 |
| 15 | Mix Binder Content | | | | | 2 | 3 |
| 16 | Agg. Specific Gravity (Gse), (Gsb) and Absorption: Check. | | | | | | 5 |
| 17 | Adjust/Respond As Appropriate & Per QCP (Don't over-react) | 6 | 9 | 6 | 6 | 5 | 6 |
| 18 | Verify Success of Changes & Check Impact on Other Control Factors | 7 | 10 | 7 | 7 | 6 | 7 |
| 19 | QCP Addendum: Submit if Applicable | 8 | 11 | 8 | 8 | 7 | 8 |

Figure 6-6. Mixture Troubleshooting Chart

QUALITY CONTROL PLAN

Each Producer providing QC/QA HMA, HMA, or SMA under the Certified Hot Mix Asphalt Producer Program is required to have a written QCP that is plant specific and is the basis of control. The QCP contains, but is not limited to, the methods of sampling, testing, calibration, verification, inspection, and anticipated frequencies.

The QCP includes the following information for each Certified Plant.

- 1) The location of the Certified Plant site, including the county and reference to the nearest identifiable points such as highway and towns.
- 2) The name, telephone number, duties, and employer of the Management Representative and Certified Asphalt Technician(s). The duties of all other personnel responsible for implementation of the QCP are also included.
- 3) A list of test equipment that is calibrated or verified, the test methods and frequency of calibration or verification of the equipment, and a statement of accessibility of the laboratory to INDOT personnel.

If the laboratory is not located at the Certified Plant, the location of the laboratory is required to be designated, and the procedure for transporting the mixture to the laboratory included
- 4) A plant site layout diagram that includes the location of the stockpile area, binder tanks, fuel tank, stabilizing additive supply, anti-adhesive supply, field laboratory, visitor parking area and mixing plant.
- 5) A plan for controls of the aggregate and recycled material stockpiles. Controls for identification of stockpiles by signing or other acceptable methods, techniques for construction of proper stockpiles, and cold bin loading procedures to prevent overflow of material from one bin into another are required to be included.
- 6) A plan for the identification of the grade of binder in each storage tank and the use of more than one binder grade in a binder tank. The sampling location is required to be indicated.

- 7) A plan for the production of WMA. The necessary plant modifications, plant production start-up process, planned mixture production temperature ranges, and moisture testing on mixtures sampled at the plant for each DMF / JMF shall be included.
- 8) The procedure for the consistent uniform addition of baghouse fines when returned into the mixing plant.
- 9) The procedure for the consistent uniform addition of stabilizing additives into the mixing plant.
- 10) The procedure for using an anti-adhesive agent for the truck bed, and a statement that the agent is on the list of Approved Anti-Adhesive Agents.
- 11) The procedure for sealing the surge bin when used for extended storage of the mixture and the method to prevent the discharge when the mixture falls below the top of the cone. The written approval of the surge bin is required to be included.
- 12) The procedure for loading mixture into the trucks.
- 13) A sampling plan that includes locations, test methods, devices, techniques, frequencies, and splitting procedures.
- 14) A testing plan that includes the types of tests, and test methods.
- 15) A description of any other process control techniques that may be used beyond the minimum required by INDOT. These controls may include, but are not limited to:
 - a) Different types or greater frequencies of material testing
 - b) Visual checks and monitoring of plant production
- 16) A statement of the procedure for handling addenda to the QCP including a time schedule for submittal.
- 17) A documentation plan with details on control charting, test data, and the diary. Copies of the forms may be included.

A QCP checklist (Appendix D) is provided to assure that all the applicable items required in **ITM 583** are addressed in the QCP.

ADDENDA

Addenda are defined as an addition or deletion to the QCP. Each page of the QCP that is revised is required to include the HMA plant number, date of revision, and means of identifying the revision. The addenda are required to be signed and dated by the Management Representative and subsequently signed and dated when approved by the Testing Engineer.

Revisions for HMA plant major components, Certified Asphalt Technicians, and movement of the HMA plant are submitted in the format of a QCP Annex (Appendix D) as they occur. Upon approval by the District Testing Engineer, the QCP Annex is placed in the Appendix of the QCP until such time that the revisions are incorporated into the QCP.

Revisions, other than items on the QCP Annex, are maintained on an Addenda Summary Sheet. The Addenda Summary Sheet is a page of the QCP Appendix that is used to record a brief description of the revision until such time that the revision is incorporated into the QCP.

Addenda may be submitted at the audit close-out meeting or within the first two months of each calendar year. The addenda are required to include items on the QCP Annex, items on the Addenda Summary Sheet, and any other necessary revisions at the time of submittal. Upon incorporation into the QCP as addenda, the QCP annex and items on the Addenda Summary Sheet are removed from the QCP Appendix.

CERTIFICATION

Each Producer requesting to establish a Certified Plant is required do so in writing to the Manager, Office of Materials Management. Upon receipt of the request for certification, the District is notified to inspect the plant and laboratory.

The plant inspection, including the correction of any deficiencies and calibration of all meters, scales and other measuring devices, is required to be completed prior to certification.

Each plant meeting the requirements of the Program is certified upon the approval of the QCP. Movement of the Certified Plant to a new location requires submittal of a QCP Annex, and verification of the calibration of all meters, scales, and other measuring devices.