SECTION 836 QMP - HMA

Hot Mix Asphalt (HMA) QMP sampling, testing, materials properties, and documentation as prescribed in CMM 836 are mobilized into the contract by standard spec 460.2.8.

836.1 General

836.1.1 Overview

This section addresses the standard specification for QMP, Asphaltic Mixture.

The QMP for Hot Mix Asphalt (HMA) is detailed in standard spec 460.2.8. Overview - WisDOT QMP Requirements:

- Personnel and required certifications (CMM 836.2 and standard spec 460.2.8.2.1.1)
- Laboratory facilities (standard spec 460.2.8.2.1.2)
- Random sampling and sampling frequency (CMM 836.4 and standard spec 460.2.8.2.1.3)
- Required testing (and calculated properties) (CMM 836.6 and standard spec 460.2.8.2.1.3)
  - Mixture bulk specific gravity (Gmb)
  - Mixture maximum specific gravity (Gmm)
  - Air voids (Va)
  - VMA (voids in mineral aggregate)
  - Aggregate gradation
  - Percent binder content
- Documentation (CMM 836.8 and standard spec 460.2.8.2.1.4)
  - Records
  - Control charts
- Control limits (standard spec 460.2.8.2.1.5)
- Warning bands
- Job mix formula adjustments (CMM 836.6.13.1 and standard spec 460.2.8.2.1.6)
- Corrective action (standard spec 460.2.8.2.1.7)
- Verification program (CMM 836.9 and standard spec 460.2.8.3.1)

836.1.2 Definitions

Interpret HMA related definitions used in 836 as follows:

Rule of retained	Split samples for comparison testing are retained. In order to test a retained portion of any sample, communications must occur between the department and contractor QMP teams. The department has ownership of QMP required split samples. There is implied joint ownership between contractor and department on any additional QC samples recorded.
Mixture production days	Days of production of a specific design mixture being tested.
Nonconforming materials	Mixture not meeting acceptable verification parameters but allowed to be left in place with appropriate payment reduction.
Unacceptable materials	Mixture not meeting acceptable verification parameters and being required to be removed and replaced.
Teams	Personnel listed on QMP organizational charts.

836.2 Personnel Requirements (Through HTCP)

The following list summarizes minimum personnel requirements and associated certifications to satisfy QMP Asphalt activities.

1. QC: Production process
   - Sampling: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Transportation Materials Sampling Technician (TMS)).
   - Production Control Testing: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Hot Mix Asphalt, Technician I, Production Tester (HMA-IPT))
   - Production process changes: HMA Tech certified at a level recognized for production process control and troubleshooting (HTCP-certified Hot Mix Asphalt, Trouble Shooting, Process Control Technician (HMA-TPC)).
   - Mix design: HMA Tech certified at a level recognized for conducting mix designs and report submittals (HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals Technician (HMA-MD)).
2. QV: Department quality verification

- Sampling: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Transportation Materials Sampling Technician (TMS)).
- Production Control Testing: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Hot Mix Asphalt, Technician I, Production Tester (HMA-IPT))
- Production process change review: HMATech certified at a level recognized for reviewing mix design work (HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technician)) or HMA Tech certified at a level recognized for conducting mix designs and report submittals (HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals Technician (HMA-MD)).

836.3 Laboratory Requirements

The laboratory must be:

- Furnished with equipment to comply with daily testing and communication requirements (calibrated testing equipment, phones, copy machines, etc.).
- Located at the plant site and operational before production.
- A Wisconsin Laboratory Qualification Program participant.

The intent is for the G_{mm} and G_{mb} materials to be tested at the same facility.

836.4 Sampling Hot Mix Asphalt

At the beginning of each day the contractor determines the anticipated tonnage to be produced. The frequency of sampling (minimum number of required tests for the day's anticipated production) is defined by the latest (QMP) HMA mixture standard spec 460.2.8.2.1.3. A test sample is obtained randomly from each sublot.

Example 1

Expected day's production is 1,900 tons. The number of required samples = 3 (per QMP standard spec 460.2.8.2.1.3).

Sample 1 – from 50 to 600 tons.
Sample 2 – from 601 to 1500 tons.
Sample 3 – from 1501 to 2700 tons.

The approximate location of each sample within the prescribed sublots is determined by selecting random numbers using WTM D3665 or by using a calculator or computerized spreadsheet that has a random number generator. The random numbers selected are used in determining when a sample is taken and will be multiplied by the sublot tonnage. This number will then be added to the final tonnage of the previous sublot to yield the approximate cumulative tonnage of when each sample will be taken.

To allow for plant start-up variability, the procedure calls for the first random sample to be taken at 50 tons or greater per production day (not intended to be taken in the first two truckloads). Random samples calculated for 0-50 ton should be taken in the next truck (51-75 ton).

Example 2

Required Sample	Sublot Sample Tonnage Range	Random No. ASTM D3665	Sublot Sample Ton (Random No. x Sublot ton)	End of Previous. Range	Cumulative Sample Tonnage
1	50 - 600	0.572	RN x 600= 343	0	343
2	601 - 1500	0.353	RN x 900= 318	600	918
3	1501 - 1900	0.656	RN x 400= 262	1500	1762

This procedure is used for any number of samples per day.

If the anticipated day's production is 1900 tons, then the third random sample would be calculated between 1501 and 1900 tons (i.e., 0.656 x 400 = 262 and 262 + 1500 = 1762). If production doesn't meet the anticipated tonnage to allow for obtaining the next randomly generated sample, then an additional sample will be taken within the last 100 tons of the day to fulfill the sampling frequency requirement defined in standard spec 460.2.8.2.1.3.1 (5) (Document reasons for any non-compliance Note: If this scenario occurs, by definition, this sample qualifies as being a random sample within the QMP program

frequency requirements, meaning, if anticipated tonnage is exceeded, a second sample should not be taken within the same interval.

The plant operator should not be advised ahead of time when samples are to be taken.

If belt samples are used during troubleshooting, the blended aggregate will be obtained when the mixture production tonnage approximates the sample tonnage. For plants with storage silos, this could be up to 60 minutes in advance of the mixture sample that's taken when the required tonnage is shipped from the plant.

QC Sample:

- Sample size only requires one "test" portion and one "retained" portion.

QV Sample:

- Must be directly observed by the project engineer.
- Project engineer takes immediate possession.
- The initial split of QV and QV-retained, can be performed by using a quartermaster. If the contractor performs this split, the project engineer, before taking possession, must directly observe it.
- Any dispute resolution testing requires QV personnel to obtain any backward QC-retained samples accumulated each time a QV sample is collected. This process also requires contractor to accumulate QC-retained samples between QV samples. If QC-retains are not available for verification testing if/when needed, liability for that mixture may include back/forward to production start-up/end or next available QV sample test result in either direction.

836.4.1 Vacant

836.4.2 Vacant

836.4.2.1 Vacant

836.4.2.2 Vacant

836.5 Sample Identification

Refer to WTM R97 section 6 in the Manual of Test Procedures for sample identification requirements. Figure 836-1 provides an example label.

FIGURE 836-1 Example of Sample Labeling

Contractor - Lab:	ABC Paving - I39 Lab
Sampling Technician:	John Doe, 123433
Sample Type:	QV
State Project ID:	1155-01-01
Date:	10/1/2019
Sample Number:	9-1
Mix Type:	4 MT 58-28 S
State Mix ID:	250-1001-19
Current JMF % Binder:	5.1%
Current Gsb:	2.722
Daily Tonnage Sampled:	1,206
QV Sample Witness:	Jack Smith, 123456, XYZ Engineering

The cumulative/total tons representing mix design production are recorded on the QC data sheets.

836.5.1 Vacant

836.5.1.1 Vacant

836.5.1.2 Vacant

836.5.2 Vacant

836.5.2.1 Vacant

836.5.2.2 Vacant

836.5.3 Splitting of SMA during Main Production

After completion of the test strip, a 3-part sample is no longer used and sampling/splitting returns to two-part splits, yielding portions for testing and retained portions (i.e., QC sample yields a QC for testing and a QC-retained, while a QV sample must yield a QV sample for testing plus a QV-retained, at a minimum).

836.5.4 Vacant

836.5.5 Vacant

836.6 Required Testing and Calculated Properties

If the digit or decimal place you are rounding to is followed by 5, 6, 7, 8, or 9, round up. If the digit or decimal place you are rounding to is followed by 0, 1, 2, 3, or 4, round down. For example, when rounding to the tenths place, 14.150 becomes 14.2 and 14.149 becomes 14.1.

836.6.1 QC Tests

QC testing must be completed, and data posted, on the day the sample was taken or as approved by the project engineer**.**

For administration of projects requiring only one, two, or three single tests per mix design, apply the following tolerances for mixture evaluation:

- Va = 1.5 - 5.0% (2.5 - 6.5% for SMA)
- VMA = - 1.0 from required minimums specified in standard spec 460.2.2.3, table 460-1
- AC = within -0.5 of JMF (determined by ignition oven method according to WTM T308, chemical extraction according to AASHTO T164 Method A or B, or automated extraction according to WTM D8159.

For results not meeting the above ranges, apply pay in accordance with the "Produced Outside JMF Limits" guidance listed in standard spec 460.5.2.1.

836.6.2 Vacant

836.6.3 Asphalt Binder Content (AC) Determination

Asphalt binder content will be determined by one of the following methods:

- Chemical extraction according to AASHTO T164 Method A or B
- Automated extraction according to WTM D8159.
- Ignition oven according to WTM T308. If the department is using an ignition oven to determine AC, conform to WTM H-003.

836.6.3.1 Vacant

836.6.3.2 Vacant

836.6.3.3 Vacant

836.6.3.4 Vacant

836.6.3.5 Vacant

836.6.3.6 Vacant

836.6.3.7 Vacant

836.6.3.7.1 Vacant

836.6.3.7.2 Vacant

836.6.3.7.3 Vacant

836.6.3.7.3.1 Vacant

836.6.3.7.3.2 Vacant

836.6.3.7.3.3 Vacant

836.6.3.7.3.4 Vacant

836.6.3.8 Vacant

836.6.4 Vacant

836.6.5 Vacant

836.6.6 Vacant

836.6.7 Dryback Procedure for Absorptive Aggregates

Run dryback procedure, corrected G_{mm}, using WTM T209, Supplemental Procedure for Porous Aggregates.

- The dryback procedure is required for aggregate JMF blends with moisture absorption greater than or equal to 2.0%.
- Run a dryback procedure on Day 1-Sample 1 and determine a dryback correction factor for that test. Average the test dryback correction factor with the design JMF dryback correction factor and apply to the test data for a new G_{mm}. If the new average correction factor changes the G_{mm} by less than 0.010 then use the design JMF dryback correction factor until otherwise determined by additional testing.
- Run a dryback procedure every other day of production on the first test sample, or any time there is a change in binder content greater than 0.1%, or a change in component blend percentages greater than

10% (or 20% combined), using the same averaging method as above to validate the original design JMF dryback correction factor.

- If any average dryback correction factor changes the G_{mm} by more than 0.010, check for math or testing error first, otherwise a new dryback correction factor must be established by running drybacks on the next three samples. Average the new dryback correction factors and establish that average as the new JMF dryback correction factor.

836.6.8 Vacant

836.6.9 Voids in Mineral Aggregate (VMA)

Voids in mineral aggregate is calculated using the aggregate bulk specific gravity, G_{sb}, from the contractor mix design (unless a blend change has occurred in which case a new Gsb will be calculated), the asphalt content (P_b determined by one of the methods listed in CMM 836.6.3), and the average SGC specimen bulk specific gravity, G_{mb}, as follows (calculate and record to 0.1.):

$$VMA,\% = 100 - \frac{G_{mb} \times (100 - P_b)}{G_{sb}}$$

836.6.10 Vacant

836.6.10.1 Vacant

836.6.10.2 Vacant

836.6.10.3 Vacant

836.6.11 Vacant

836.6.12 Additional Formulas and Example Calculations

1. Determining the aggregate effective specific gravity (Gse) for the following:

$$G_{se} = \frac{100 - P_b}{\left[\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)\right]} = \frac{100 - 4.5}{\left[\left(\frac{100}{2.567}\right) - \left(\frac{4.5}{1.030}\right)\right]} = 2.761$$

Given:

Pb = 4.5
Gmm = 2.567
Gb = 1.030

2. Determining the percent of asphalt content (Pb) for the following:

$$P_b = 100 \times \left(\frac{G_b}{G_{mm}}\right) \times \frac{(G_{se} - G_{mm})}{(G_{se} - G_b)} = 100 \times \left(\frac{1.030}{2.567}\right) \times \frac{(2.761 - 2.567)}{(2.761 - 1.030)} = 4.5$$

Given:

Gmm = 2.567
Gb = 1.030
Gse = 2.761

3. Determining the asphalt absorption, P_{ba}, for the following:

$$P_{ba} = 100 \times \frac{(G_{se} - G_{sb})}{(G_{sb} \times G_{se})} \times G_b =$$

$$100 \times \frac{(2.761 - 2.703)}{(2.703 \times 2.761)} \times 1.031 = 100 \times \frac{0.058}{7.463} \times 1.031 = 0.8$$

Given:

Gse = 2.761
Gsb = 2.703
Gb = 1.030

4. Determining the effective asphalt content, P_{be}, of the asphaltic mixture for the following:

$$P_{be} = P_b - \left(\frac{P_{ba}}{100}\right) \times P_s = 5.3 - \left(\frac{.8}{100}\right) \times 94.7 = 4.5$$

Given:

Pb = 5.3
Pba = 0.8

Ps = 94.7

5. Determining the percent voids filled with asphalt (VFA) for the following compacted mixture:

$$VFA = 100 \times \frac{(VMA - V_a)}{(VMA)} = 100 \times \frac{(14.4 - 3.7)}{(14.4)} = 74.3$$

Given:

VMA = 14.4

Va = 3.7

6. Determining the dust to binder ratio (or DP: Dust Proportion):

$$Dust\,to\,Binder\,Ratio = \frac{\%\ passing\ 0.075}{P_{be}} = \frac{5.0}{4.5} = 1.1$$

Given:

Pbe = 4.5

% passing 0.075 = 5.0

836.6.13 Field Adjusted JMF

The JMF may be adjusted in the field based on production test results see CMM 866.2.

When the JMF asphalt content is increased by 0.2% or more start new running average for G_{mm}. The compaction target maximum density for the day of the target change can be calculated using the most recent G_{se} and percent asphalt binder (P_b) for the new JMF and G_b (binder specific gravity) at 77 F from the mix design.

836.6.13.1 Job Mix Formula (JMF) Changes

Changes made to the current Job Mix Formula (JMF) during production must be submitted to the HMA-MD Technician representing the department for approval. Scenarios requiring a JMF change include but are not limited to the following:

- Decrease in JMF target binder content of 0.1% maximum.
- Change in asphalt binder PG grade (with the project engineer's approval and complying with CMM 866.2.3.2).
- Addition of an additive, except approved compaction aids.
- Changes to an additive type or dosage rate identified on a JMF.
- Change to JMF aggregate gradation percentages within aggregate gradation master range according to table 460-1.

A JMF target binder content decrease exceeding 0.1% from the original JMF target, elimination or addition of any aggregate component, or changes to the design aggregate component blend percentages exceeding 20%, in combination will require a new mix design.

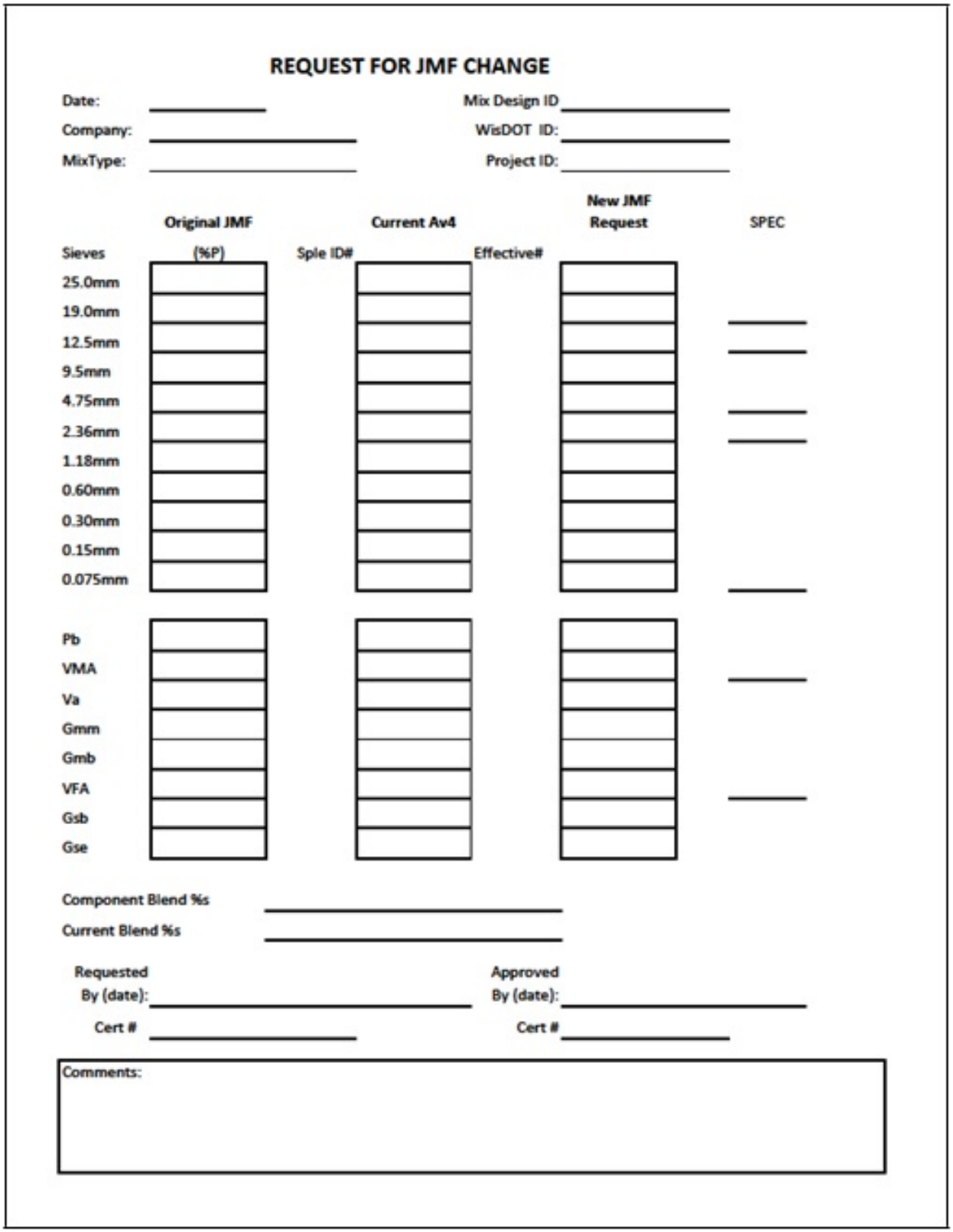
No JMF change requests are to occur before completion of three individual production tests for changes to a control sieve or mixture AC content. Recycled asphaltic binder change requests require two RAM extractions according to CMM 836.6.15. Data from prior production testing do not have to be from state projects but must be sampled and tested by HTCP certified personnel. Testing must occur in a WisDOT approved laboratory, following WisDOT approved methods. When requesting JMF changes, laboratory results must be submitted electronically to substantiate using materials from non-WisDOT projects.

The contractor notifies the project engineer of proposed changes using the "Request for JMF Change" form shown in figure 836-2. Comments must include the sample test number indicating when the change becomes effective. Production adjustments and JMF change request submittals cannot cause target values to violate design requirements. Production tolerances may exceed those targets.

The requested change can become effective up to four individual test points before the current average of four that is indicated on the submitted form. Electronic documentation indicating that the contractor and project engineer had discussed a possible JMF Change must exist, and support this request, if the department is to accept the change. The "Request for JMF Change" form must indicate the lot and sublot where the JMF change will become effective.

Further changes are not allowed until six additional individual test points, according to the normal sampling frequency, for the affected mix property are documented. Each JMF sieve is considered an individual mix property. Control charts for affected properties must accompany JMF change requests.

FIGURE 836-2 Request for JMF Change Form



REQUEST FOR JMF CHANGE

Date: _____ Mix Design ID _____

Company: _____ WisDOT ID: _____

MixType: _____ Project ID: _____

Sieves	Original JMF (%P)	Current Av4 Sple ID#	Effective#	New JMF Request	SPEC
25.0mm					
19.0mm					
12.5mm					
9.5mm					
4.75mm					
2.36mm					
1.18mm					
0.60mm					
0.30mm					
0.15mm					
0.075mm					
Pb					
VMA					
Va					
Gmm					
Gmb					
VFA					
Gsb					
Gse					

Component Blend %s _____

Current Blend %s _____

Requested By (date): _____ Approved By (date): _____

Cert # _____ Cert # _____

Comments:

836.6.14 Production Tensile Strength Ratio Tests

The tensile strength ratio (TSR) is determined according to the procedures in WTM T283. After manufacturing the specimens at the plant, they may be tested in an offsite laboratory. Mixes qualifying for field TSR testing are defined as one of the following:

- Any WMA
- HMA mixes with NMAS of #4 (12.5 mm) or #5 (9.5 mm) gradation with a design TSR < 0.86.

For production TSR, follow WisDOT PWL sampling & splitting procedure, yielding two boxes of material for each the contractor and BTS specifically for TSR testing. The total weight of material sent to the department will be a minimum of 100 lbs. The minimum production TSR requirement is 0.80. In the event TSR <0.80, corrective action must be taken and an additional random sample will be taken by the department to monitor impact of corrective action.

836.6.15 RAM Stockpile Samples

When test results indicate that a change has occurred in the RAM asphalt content, a change in the design RAM asphalt percentage may be requested by the contractor or the project engineer. The request will include at least two recent RAM extractions and also identify all applicable mix designs to be affected. For each affected mix design a new percent binder replacement (Pbr) needs to be calculated and reported. The requested change will be reviewed for the department by an HTCP-Certified HMA Technician at a level recognized for mix design (HMA MD Technician), and a revised JMF can be issued.

836.7 HMA QMP Documentation

836.7.1 General

The contractor is responsible for documenting all observations, records of inspection, and test results on a daily basis. Results of observations and records of inspection must be noted as they occur in a permanent field record. The testing records and control charts must be available in the QC laboratory at the asphalt plant.

The contractor must maintain standardized control charts. Test results obtained by the contractor must be recorded on the control charts the same day the tests are conducted. The aggregate gradation test data must be recorded on the standardized control charts for all randomly selected production samples tested.

Sieve sizes for aggregate gradation tests must include the maximum aggregate sieve size, the NMAS sieve, and any following sieves falling below the NMAS sieve in table 460-1:

1" (25.0mm)	3/4"(19.0mm)	1/2"(12.5mm)	3/8"(9.5mm)	# 4 (4.75mm)	#8(2.36mm)
# 16 (1.18mm)	# 30 (0.60mm)	# 50 (0.30mm)	# 100 (0.15mm)	# 200(0.075mm)	

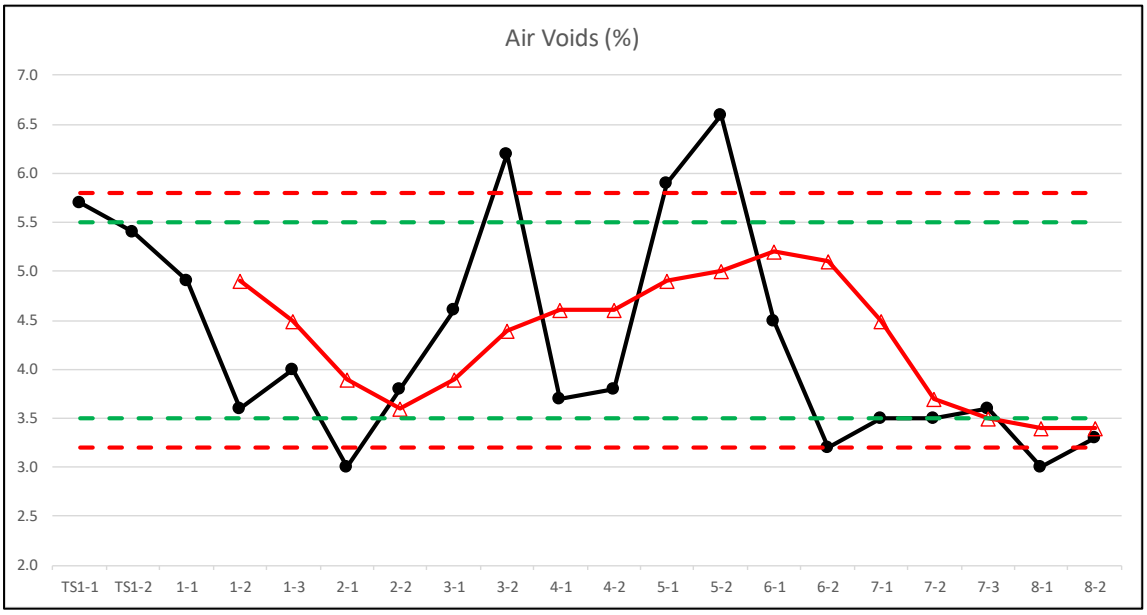
836.7.2 Example Pay Reductions for Control Charts

The engineer will evaluate contractor-supplied control charts and compare the 4-point running average to the control limits specified in standard spec 460.2.8.2.1.5 and the corrective action specified in standard spec 460.2.8.2.1.7. HMA individual data points are not typically analyzed independently. However, individual SMA air voids test results are subject to the additional corrective action criteria specified in standard spec 460.2.8.2.1.7(7) and to pay adjustment as specified in standard spec 460.5.2.1(5) in addition to the control limits that apply to the 4-point running average.

The following example illustrates how to make a pay reduction for SMA air voids.

Example 4

Running Average Analysis of Mixture Samples										
WisDOT Mix ID #: 250-0111-2020				Mix Type: 4 SMA 58-28 V			Site:			
				Cumulative	Gmb		Gmm		Air Voids	
Sample	Sample Date	Lot	Sublot	Sample Tons	Result	Mean	Result	Mean	Result	Mean
5001	7/11/2020	TS1	1	-	2.330		2.470		5.7	
5002	7/11/2020	TS1	2	-	2.360		2.496		5.4	
5755	7/27/2020	1	1	437.0	2.347		2.467		4.9	
5757	7/28/2020	1	2	1495.0	2.373	2.353	2.462	2.474	3.6	4.9
5758	7/28/2020	1	3	2005.0	2.364	2.361	2.463	2.472	4.0	4.5
6500	8/13/2020	2	1	2411.1	2.396	2.370	2.469	2.465	3.0	3.9
6501	8/14/2020	2	2	2846.1	2.375	2.377	2.468	2.466	3.8	3.6
6564	8/14/2020	3	1	3220.7	2.352	2.372	2.466	2.467	4.6	3.9
6567	8/15/2020	3	2	3851.7	2.327	2.363	2.480	2.471	6.2	4.4
6618	8/15/2020	4	1	4650.4	2.377	2.358	2.468	2.471	3.7	4.6
6622	8/15/2020	4	2	5392.4	2.383	2.360	2.477	2.473	3.8	4.6
6738	8/18/2020	5	1	6263.3	2.324	2.353	2.470	2.474	5.9	4.9
6739	8/18/2020	5	2	6941.3	2.307	2.348	2.470	2.471	6.6	5.0
6754	8/19/2020	6	1	7143.0	2.362	2.344	2.473	2.473	4.5	5.2
6758	8/20/2020	6	2	7596.0	2.389	2.346	2.467	2.470	3.2	5.1
7563	9/7/2020	7	1	8031.8	2.392	2.363	2.479	2.472	3.5	4.5
7572	9/8/2020	7	2	9247.8	2.396	2.385	2.483	2.476	3.5	3.7
7573	9/8/2020	7	3	9267.8	2.392	2.392	2.481	2.478	3.6	3.5
7723	9/12/2020	8	1	10472.2	2.397	2.394	2.471	2.479	3.0	3.4
7724	9/12/2020	8	2	10635.2	2.386	2.393	2.468	2.476	3.3	3.4
Count					20		20		20	
Mean					2.366		2.472		4.290	
JMF					2.358		2.469		4.5	
Warning Band (L)									3.5	
Warning Band (H)									5.5	
JMF(L)									3.2	
JMF(H)									5.8	



Example 4A

The first instance of nonconforming air voids in this example involves sublots 2-1, and 3-2. These two individual air voids tests within four consecutive points exceed the JMF limits.

The specified pay adjustment would be applied to the material from the point where an individual test is outside the JMF limit until another individual QV or QC test is within the JMF limits. In this case, the department would pay 80% of the contract unit price for the material from sublot 2-1 to 2-2 (435 tons) and from sublot 3-2 to 4-1 (798.7 tons).

Example 4b

The second instance of nonconforming air voids in this example involves sublots 5-1 and 5-2. These two individual air voids tests within four consecutive points exceed the JMF limits. In this case, the department would pay 80% of the contract unit price for the material from sublot 5-1 to 6-1 (879.7 tons).

Note: Two consecutive four-point running average values (sublots 8-1 and 8-2) exceed the warning limits requiring the contractor to stop production and make adjustments. Production can not resume until the engineer has been notified of the changes made. A new running average will be calculated at the fourth test after the required production stop.

836.8 Documentation

836.8.1 QC Records

In addition to the requirements of standard spec 460.2.8.2.1.4.1, the contractor must provide:

- A cumulative tonnage value and current control charts to the engineer daily.
- Random number generation results and associated tonnage for QMP sampling.
- When submitting charts and running average calculation sheets the contractor mix design ID and WisDOT 250 report number must be included on each sheet. Full name of qualified sampler, tester and qualified lab locations should be on individual sample test property worksheets.
- Blend change history including percentages of aggregates, RAM, AC%, and additives.
- Individual sample test property worksheets (*Note:* More detailed information may be requested or observed during actual production for evaluation purposes. To verify compliance with appropriate test procedure requirements, this information needs to be made available during that on-site evaluation).

Records should be the original (handwritten or electronic) documents. However, the original "source" documents should be maintained in the project records. If the data is entered directly into an electronic document then that is acceptable as the source document. If the original document is handwritten and then transferred to an electronic document, the original handwritten document should be maintained as the "source" document.

When supplying the original "source" document, a scanned copy is acceptable.

Electronic documents are considered to be acceptable during construction, but the original documents need to be submitted after project completion for final project closeout.

836.8.2 QV Records

The contractor needs to post results of department QV testing on the appropriate QC charts for air voids, AC%, and VMA, each represented with a unique symbol.

836.9 Quality Verification Program

836.9.1 Monitoring Contractor QMP

836.9.1.1 Preconstruction

The QV team is responsible for obtaining the following information:

- Obtain WisDOT test number of the quality test report for the aggregate source being used. If source quality testing hasn't been completed, notify the BTS laboratory.
- Obtain the WisDOT test number of the mix design intended for use or a copy of the contractor's mix design, the review report, if available, from department's Materials Tracking system, and any contract special provisions.
- Verify that the QC team personnel have the proper certifications.
- Verify that the QC Laboratory facility is WisDOT qualified and has the equipment required by the QMP specification (inclusive of communication devices).

Review any procedures for determining reheat correction factors and for the G_{mm} dry back correction factor (if applicable). Discuss any necessary calibrations, or pending recalibrations, for the gyratory compactor and what procedure will be used.

836.9.1.2 During Production

During production, the QV team should, as often as they feel necessary:

1. Random Sampling:
   - Check the QC procedures for proper random number generation for all samples.
   - Verify the QC team is aware they are not to inform the plant before the random sampling will occur.
2. Samples:
   - Ensure all required samples are being taken for mixture properties and blended aggregate gradations.

- Ensure that proper sampling and splitting procedures are being used and the field sample size is large enough to accomplish required testing.
- Ensure that stockpile samples are taken and tested for reclaimed asphaltic pavement (RAP) when applicable.
- Ensure tensile strength ratio (TSR) tests have been conducted at proper intervals for mixtures in standard spec 460.2.8.2.1.3.1(6).
- Ensure that the retained samples (mix and blended aggregate) are properly labeled and stored in a dry protected area.

3. Testing:
   - Observe the reduction of the field samples to test size.
   - Observe the testing procedures paying attention to temperature of test samples before compaction, compaction efforts, times allotted between tasks, dry backs, etc.
   - Review data calculations.
4. Control charts:
   - Check to see that required control charts are present and up to date.
   - Check to see that control limits and warning bands are accurately drawn.
   - Check to see that the proper values are being plotted correctly.
5. Documentation:
   - Check to see that records of compliance are being documented and are up to date.
   - Check to see that adjustments to mixtures and JMF changes are noted on field records.
   - Check to see that records have been provided to the QV team on a daily basis.

836.9.2 Verification Sampling

Product quality verification sampling is the responsibility of the department's QV team. This requires QV personnel to obtain any backward QC-retained samples accumulated each time a QV sample is collected. This process also requires contractor to accumulate QC-retained samples between QV samples. If QC-retains are not available for verification testing if/when needed, liability for that mixture may include back/forward to production start-up/end or next available QV sample test result in either direction.

836.9.2.1 Plant Sampling

Samples from the truck box will be taken by a member of the contractor QC team, and directly observed by the QV team member. In addition, if the initial split (QV / QV-retained) is performed by the contractor, it is also to be directly observed by the QV team member.

The QV team will determine and document the random sampling procedure employed for mixture verification samples. QV random samples should be determined from production tonnage.

If some other method is used, it should be mutually agreed upon between the QV and QC teams and documented before taking place.

The contract language specifies "two mixture production days" after the sample has been obtained by the contractor as the time within which the QV personnel must respond to the QC team relative to the agreement of data results. The intent is to provide information and feedback to the QC team as soon as practical in case there is data disagreement and the potential need to stop mix production.

If the QV mixture sample temperature is 230 degrees F or higher when delivered to the testing facility, quartering may start immediately. If the temperature is below 230F, place in a 300F oven, until workable for quartering, but not to exceed two hours. Microwaves are not to be used to reheat an HMA sample.

836.9.3 Determining Acceptable Verification Parameters

Whenever a flag has been raised by disagreement of QV test results with the defined acceptable parameters, immediate investigation will occur using additional testing, troubleshooting, and dispute resolution actions.

836.9.3.1 Additional Testing

When a QV test result does not meet the specified acceptance limits specified in standard spec 460.2.8.3.1.6 the engineer must collect the following samples and send them to BTS for dispute resolution testing:

- QV-retained sample.
- All QC-retained samples backward to the last passing QV test or to the beginning of the project if no QV samples have been taken.
- All available QC-retained samples forward to the next passing QV test or to the end of the project.

The engineer must send these samples to BTS immediately for referee testing. An additional non-random QV sample will be collected either when the department representative goes to the contractor to collect the necessary QC-retained samples (or as soon as production resumes if the mix is not currently being produced). The collection and shipment of necessary QC-retained samples to BTS will not be delayed by the collection of a non-random QV sample if the mix is not currently being produced.

Below are examples of the testing of QV-retained and any needed forward and backward QC-retained samples.

Example 5

A QV sample taken following QC test 5-3, falls outside of 2.0 to 4.3% air voids (3.2 to 5.8% for SMA). The WisDOT - BTS lab tests retained portion of QV sample, along with QC-ret sample 5-3 and QC-ret 5-4 once available. The Bureau continues testing of retained samples both forward and back until a test result in each direction meets criteria for 75% pay in accordance with figure 836-3 (i.e., 1.8 to 4.6% air voids, or 2.9 to 6.1% for SMA). If this criterion has not been met and no further QC-retained sample exists in a given direction, then liability for that mixture may include back to production start-up/end or QV sample.

BTS is to provide QC retained split sample testing on the nearest forward QC sample as soon as practical, and continue until the QC-retained split sample is 1.8 to 4.6% air voids and (2.9 to 6.1% for SMA) and within 0.7% minimum VMA.

In addition, when the QV team is back on the site to obtain the additional QC-retained samples, another QV sample will be taken.

Example 6

The QV sample taken following QC test 5-3, falls outside acceptable parameters. The QV team returns to the plant site on day 7 and obtains any QC-ret samples forward of sample 5-4 available at that time (to be sent to the WisDOT-BTS lab), and directs a new QV sample be taken representing day 7.

836.9.3.2 Troubleshooting

The following points are to be considered and re-checked:

- Calculations.
- QC data trends.
- Equipment calibration records.
- Sampling and splitting observations/notes.
- Proper use of re-heat correction factors.

If a 0.020 or greater variability exists between QC and reheated samples (matching QC-retained portion), then a Gmb reheat correction factor is determined to aid in troubleshooting.

- Gmb reheat correction factor (calculated to 0.001) = Gmb (un-reheated) / Gmb (reheated).
- Apply the correction factor to the reheated sample: Corrected Gmb = Gmb (reheated) X correction factor.
- When comparing the uncorrected Gmb to the corrected Gmb, if the difference is less than 0.005, then the correction factor will not be used.

If a 0.015 or greater variability exists between QC and reheated samples (matching QC-retained portion), then a Gmm reheat correction factor is determined to aid in troubleshooting. It should be calculated to 0.001.

- Gmm reheat correction factor (calculated to 0.001) = Gmm (un-reheated) / Gmm (reheated).
- Apply the correction factor to the reheated sample: Corrected Gmm = Gmm (reheated) * correction factor.
- When comparing the uncorrected Gmm to the corrected Gmm, if the difference is less than 0.005, then the correction factor will not be used.

836.9.3.3 Dispute Resolution

For the results of the additional testing conducted according to CMM 836.9.3, the contract language specifies reporting the results of the referee testing within three business days after receipt of the samples. The receipt day refers to receipt of the samples at BTS. The intent is to provide test information and feedback to the QC/QV team as soon as practical and targeting within 7 business days of the date of the failing QV sample.

At the completion of dispute resolution testing (QV-ret and required backward and forward QC-ret) the BTS personnel dealing with asphalt mix designs will provide documentation to the QV team recommending tonnages to be affected based on the following information:

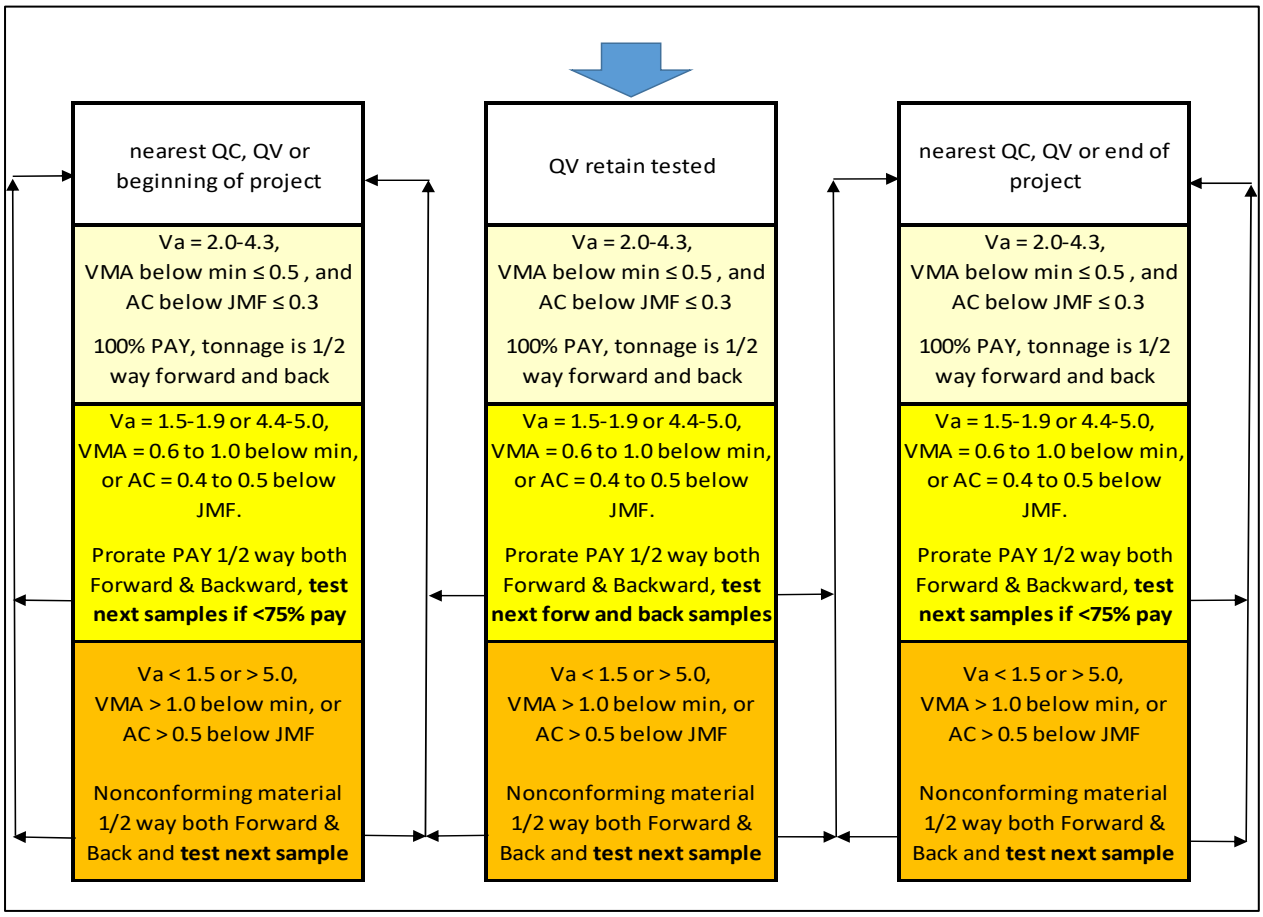
- Gmm & Gmb as measured by BTS.
- Air Voids as calculated from BTS volumetric data.

- VMA of QC/QV-ret samples tested by BTS.
- Asphalt binder % (AC) as determined by BTS using automated extraction.

The general process flow chart for dispute resolution is shown in figure 836-3. Example scenarios are provided in figure 836-4 (based on HMA requirements). If the range of affected tonnage is determined to be at the QV (isolated problem), a pay adjustment calculated to tonnage halfway between samples will be assessed. There is no intent to use multiple pay adjustments, but the lowest percent pay will supersede others.

The QV team will further complete documentation responsibilities by determining the dollar amount for any affected mixture tonnage and will forward that information to appropriate project personnel and the QC team. Figure 836-5 is an example of a spreadsheet used to calculate pay adjustments.

FIGURE 836-3 HMA Dispute Resolution Flow Chart



- Pay of less than 100% on QV-retain test will result in additional testing of forward and back sample.
- Pay of less than 75% on forward or backward QC-retain will result in testing of the next forward or backward sample.
- Unacceptable material must be removed and replaced at no cost to the department. Alternatively, the engineer may allow the material to remain in place with a 50 percent payment factor.

HMA prorated pay factors (between 50 and 100% pay) are as follows:

Description	Criteria	Pay Factor
High Air Voids Pay Factor	4.3% < Va ≤ 5.0%	= 100 - (Va - 4.3) * 71.4
Low Air Voids Pay Factor	1.5% ≤ Va < 2.0%	= 100 * [1 - (2.0 - Va)]
Low VMA Pay Factor	0.5% < VMA below min ≤ 1.0%	= 100 * [1 - (percent below min. - 0.5)]
Low AC Pay Factor	0.3% < AC below JMF ≤ 0.5%	= 75

When using figure 836-3 above for dispute resolution of SMA material apply the following:

- SMA 100% pay requires: Va = 3.2 - 5.8%, VMA below min ≤ 0.5%, and AC% below JMF ≤ 0.3%.
- SMA 50% pay corresponds to: Va < 2.5% or > 6.5%, VMA below min > 1.0%, or AC% below JMF > 0.5%.

SMA Prorated Pay Factors (between 50 and 100% pay) are as follows:

Description	Criteria	Pay Factor
High Air Voids Pay Factor	5.8% < Va ≤ 6.5%	= 100 - (Va - 5.8) * 71.4
Low Air Voids Pay Factor	2.5% ≤ Va < 3.2%	= 100 - (3.2 - Va) * 71.4
Low VMA Pay Factor	0.5% < VMA below min ≤ 1.0%	= 100 * [1 - (percent below min. - 0.5)]
Low AC Pay Factor	0.3% < AC below JMF ≤ 0.5%	= 75

FIGURE 836-4 HMA Verification Dispute Resolution Scenario Examples

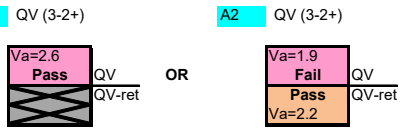
NOTE: *The following diagrams (A-H) represent standard scenarios. Specific project detail and troubleshooting activities may present cause for adjustment to this guidance*

= Testing performed by the Region
= Testing performed by the Referee third party (BTS)
= QC random production sample

A standard recommendation will be assessed based on the following requirements:

- Va is within a range of 2.0 to 4.3 percent.
- VMA is within minus 0.5 of the minimum requirement for the mix design nominal maximum aggregate size.
- AC is within minus 0.3 of the JMF

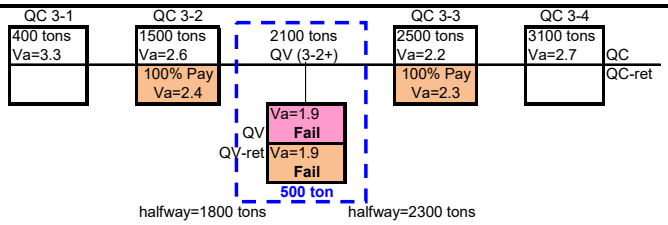
Example A



END RESULT

A **No Adjustment** (N/A) QMP Controls
**The Referee third party (BTS) test results determine the Pass/Fail status of the QV sample once it has gone into Dispute Resolution*

Example B 1



END RESULT

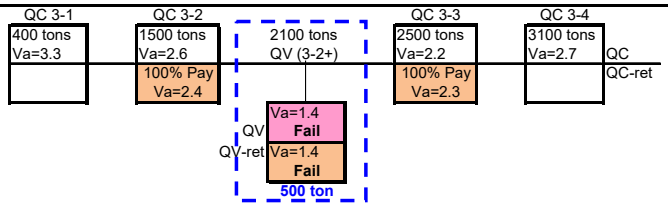
B1 **Isolated Area** : Localized Problem (Prorated)
Backward and forward QC-ret results are acceptable (100% pay)

Calculate halfway from failing QV-ret both forward and back

(ex: 2300 - 1800 = 500 ton @ 90% pay)

Percent pay for any adjustment will be determined by the tiered system presented in Figure 7

Example B 2



END RESULT

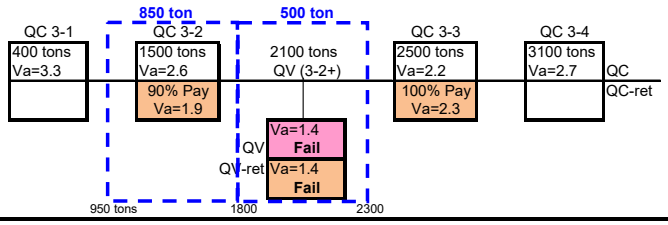
B2 **Isolated Area** : Localized Problem (50%)
Backward and forward QC-ret results are acceptable (100% pay)

Calculate halfway from failing QV-ret both forward and back

(ex: 2300 - 1800 = 500 ton @ 50% pay)

Percent pay for any adjustment will be determined by the tiered system presented in Figure 7

Example C



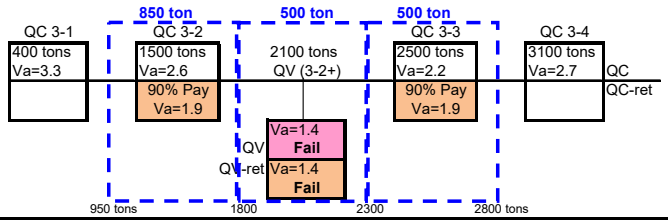
END RESULT

C **Uni-directional QC-ret <100% Pay**
Backward or forward QC-ret <100% Pay

Each test result represents the material halfway to the adjacent point. Therefore, this scenario results in one area of pay adjustment (in the Backwards direction) in addition to the initial verified QV-ret area.
Testing does not continue if QC-ret ≥75% Pay

(ex: 1800-950 = 850 ton @ 90% pay)
(ex: 2300-1800 = 500 ton @ 50% pay)

Example D



END RESULT

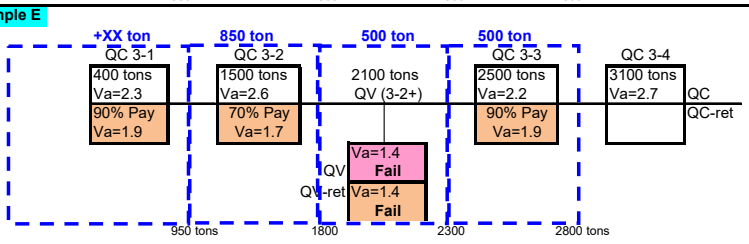
D **Bi-directional QC-ret <100% Pay**
Backward and forward QC-ret <100% Pay

This scenario results in two areas of pay adjustment in addition to the initial verified QV-ret area.

Testing does not continue if QC-ret ≥75% Pay

(ex: 1800-950 = 850 ton @ 90% pay)
(ex: 2300-1800 = 500 ton @ 50% pay)
(ex: 2800-2300 = 500 ton @ 90% pay)

Example E



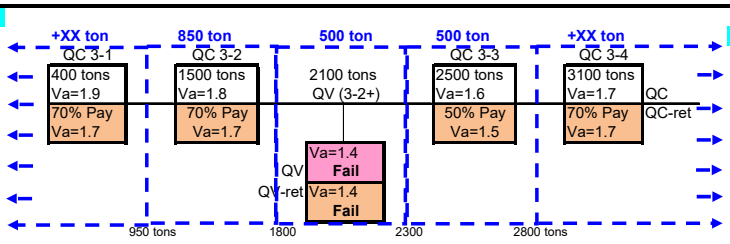
END RESULT

E **Additional Backward testing**
Backward QC-ret is < 75% Pay
Forward QC-ret is > 75% Pay

Backward testing continues beyond QC-ret 3-2, until resulting in ≥75% Pay, as seen with QC-ret 3-1.

Therefore, pay adjustment will affect tonnage halfway back to the last QC test of Day 2

Example F



END RESULT

F **Additional Forward & Backward testing**
Forward QC-ret is <75% Pay
Backward QC-ret is < 75% Pay

Both Forward & Backward testing continue until a QC-ret results in ≥75% Pay. Pay adjustements are then calculated for the appropriate tonnage per area & corresponding percent pay

Pay adjustment may continue to beginning & end of production.
Areas of 50% pay are subject to Remove & Replace

FIGURE 836-5 Adjustment Calculation Example

Project ID: xxxx-xx-xx MIX TYPE: 4 MT xx-xx S MTS Record: x-254-00xx-20xx

Recommended Adjustments	% Pay SS 460.2.8	Affected Mix Tons	Mix Bid Price	TOTAL Adjustment (w/h)
Air Void Failure	50%	500.0	$ 55.27	$ 13817.50
VMA Failure	75%	0.0	$ 55.27	$ -
				$ 13817.50
Comment:				

Alternate/Final Adjustments	% Pay SS 460.2.8	Affected Mix Tons	Mix Bid Price	TOTAL Adjustment (w/h)
Air Void Failure	50%	500.0	$ 55.27	$ -
VMA Failure	75%	0.0	$ 55.27	$ -
				$ -
REMARKS:				

Contact BTS for further assistance.

836.10 Vacant