416 ASPHALTIC CONCRETE – END PRODUCT

It is the intent of the 416 end-product specification to allow the Contractor the freedom to control the production and placement of asphaltic concrete in its entirety. With few exceptions, the Contractor is responsible for meeting the specified properties of the final product and is free to determine the best way to achieve those results. It is important to note that the Contractor performs the quality control. The Inspector's role is more of an overseer who documents construction methods, as well as the accepting of the final product. However, when problems with the Contractor's plant or paving operation arise, the Inspector should closely monitor the situation and assist the Contractor in reaching an expedient solution.

Materials, testing procedures, and construction requirements are basically the same for the various types of asphaltic concrete pavement. For the sake of brevity, most inspection procedures can be found in the "Asphalt Concrete" section of this manual. This subsection of the manual contains additional inspection procedures and contract administration requirements for specification 416.

416-2 Mix Design Criteria

Specification bands are given to identify acceptable starting points for mix design, they are NOT for production control. Once the mix design is complete and accepted there is no need for the inspector to refer to this subsection. The upper and lower limits of production control bands are found in 416-7.04 and are based on the target values given in the particular mix design for each individual project.

416-3 Materials

416-3.01 Mineral Aggregate

The biggest factors that affect the variations in asphalt mix properties are the aggregate crushing, screening, and stockpile operations. Often problems in compaction and gradation can be traced back to poor controls during crushing. It is very important for ADOT Inspectors to carefully monitor this operation and ensure the Contractor is doing all the sampling and testing properly. The Contractor has complete control of the crushing operation and ADOT does not usually interfere with this unless there is a regulatory violation referred to in Subsection 1001.

416-3.02 Mineral Admixture

Fine aggregate must be obtained from crushed gravel or crushed rock in accordance with subsection 416-3.01 of the Standard Specifications. All uncrushed material finer than the #4 sieve must be removed before crushing the aggregate. This will ensure that the fines are manufactured and less rounded. This helps achieve higher stability in the mix. The contractor may blend back as much as 15% natural fines but the blend of all the fine aggregate must meet the uncompacted voids requirement and the natural fines cannot have more than 4% finer than the #200 sieve.

Mineral admixture may be called for in the mix design. If it is required, the mineral admixture will be 1.0% by weight of the mineral aggregate. It can be as much as 2.0% if testing shows that amount is necessary to meet the Index of Retained Strength (Immersion Compression) requirements. The specifications allow three types of mineral admixture. The two types of cement must be added as a dry powder to the mineral aggregate for mixing in the pugmill. The lime must be hydrated and can be added as a dry powder or as a slurry (with water). Large chunks of mineral admixture are not allowed into the mix and the inspector should look for signs that these dry materials have been wetted during storage. There is another lime product called quicklime

(CaO) that cannot be added to the mix. When CaO is mixed with water it is slaked (hydrated) which means the water is chemically combined with it. The hydrated lime called for in the specification is slaked, but it can still look like a dry powder even though there is some water combined in it. The inspector is made aware of these differences because CaO is dangerous to handle and if blended into the asphaltic concrete it will damage it.

416-3.03 Bituminous Materials

Bituminous material will be a PG grade and the type will be found in the Special Provisions for the project.

When there is a source of asphalt cement that has not previously been used, it is a good practice to sample the asphalt cement as soon as it arrives at the plant. The acceptability of this "new" material should be determined as quickly as possible before too much pavement is placed. Acceptable certificates of compliance will be required for each load of asphalt cement, as well as for any mineral admixture before these materials are incorporated into the project.

416-4 Mix Design

Under any end-product specification (406, 416, & 417), ADOT does not verify the Contractor's mix design. ADOT only approves the lab that does the mix design. The Resident Engineer should check to ensure that a lab from the Materials Group's list of approved labs is used to perform the mix design.

The Contractor will submit the finished mix design, with the split samples used to develop it, to the field office. Before the field office forwards the mix design to the Regional Materials Lab or the Materials Pavement Testing Section for review, the Resident Engineer or Project Supervisor should review the mix design to ensure that all the information required by subsections 416-2 and 4 have been meet. In addition, checking for compliance with the mix design criteria, aggregate gradation limits, and asphalt to dust ratio, the Resident Engineer should check that the method of adding the admixture to the aggregate (with wet or dry aggregates) matches the method that will be used at the plant. Only mix designs with complete information that meet the specifications should be forwarded to the ADOT Materials Group.

For a previously used mix design, the Resident Engineer should still submit the design to the Regional Materials Lab for review to determine if additional testing is needed.

When the Department has reviewed the mix design, the target values for each mix property (such as AC content, stability, compaction, etc.) will be established from the results of the mix design. The Project Supervisor and Inspectors should become very familiar with these target values and a copy of the mix design should be available at the project site. During paving, changes to target values may occur which will affect payment factors for each lot. The Project Supervisor or Lead Inspector should track the target values on a daily basis in the daily diary. This will make sorting out acceptance values and pay adjustments much easier.

416-6 Construction Requirements

Although the 416 Standard Specifications allow the Contractor significant latitude on how asphalt is produced and placed, some inspections at the plant and at the project site will still be required. It is also a good idea to document the contractor's materials handling procedures for future reference even if we do not control the individual steps of this process.

Since the Contractor has the responsibility for quality control, the Contractor's staff should do most of the routine inspection work. ADOT Inspectors still have some involvement during paving, but most of their effort

should be focused on ensuring that both the Contractor's production and QC work are done properly and consistently. Subsection 416-6 of the Standard Specifications:

1. Describes the requirements for admixture mixing and control.

2. Requires the use of the automatic screed control device on laydown machines.

3. Requires the contractor to submit a copy of the pyrometer record at the end of each shift.

4. Specifies the use of a system to stop the mixing if mineral admixture flow is stopped.

5. Requires all core holes to be patched within 48 hours

6. Requires all vertical edges to be tacked as directed.

7. Specifies the authority to stop the work to prevent weather conditions from damaging the asphaltic concrete pavement.

416-7 Acceptance

Although acceptance testing is done by random sampling, the Inspector still has the authority under 416-7.01 to take plate samples and cores at any time and from any place if the material appears to be defective. If the Inspector observes what appears to be defective material coming from behind the paver or out of the delivery trucks, then take additional samples. This direct sampling is allowed under any of ADOT's paving specifications even though some are end product. Directed samples by the Department are not allowed for any part of the statistical analysis for the lot. The inspector is reminded to review the information on stratified random sampling and to be familiar with the proper use of random number tables (see 1331-1) or a calculator as a random number generator.

For acceptance, rejection, and payment purposes, asphaltic concrete paving production is broken down into "lots." The Inspector must always read the specifications to determine the lot size. Under the quality lot, ADOT compares mix properties such as aggregate gradation, asphalt cement content, effective voids, and stability, with the values specified in the mix design and contract documents. If any one of these properties is in reject, the entire lot is rejected and not just the area of pavement where the particular sample was taken. Compaction lots are handled in the same way.

Sand equivalent, fractured (faces) coarse aggregate particles, uncompacted void content, and smoothness are part of the acceptance testing, but when failures occur only the sections of pavement represented by that particular test are rejected. The contractor has the option of submitting a revised mix design or reworking the stockpiles to correct the deficiencies. Continual retesting until a passing result occurs is not a valid solution.

Significant deviations in asphalt content from the percentage called for in the design (more than $\pm$0.2%) should be discussed and resolved with the Contractor. If the plant is dedicated to exclusive production for one project, the Engineer can evaluate the asphalt content reported from the acceptance lab and compare it with the contractor's hot plant report. If the discrepancy is greater than 0.1%, a correction value should be applied.

Once a section of paving has been completed, the Inspectors are now in a position to accept or reject that portion of the work. They should:

1. Check for straight edge tolerances particularly, at the joints.

2. Layout the compaction core locations.

3. Mark lots which are in reject due to any failures in mix properties (such as asphalt cement content, gradation, or stability).

For each mixture-properties lot, the acceptance lab will test for gradation, AC content, effective voids, and stability (from the four plate samples). For each compaction-lot the acceptance lab will test density from the cores. They will issue the results on a form similar to the one shown in Exhibit AC-4. This form will have the pay factors computed for the lot. If the test results show failure of any of the mix properties or compaction requirements, the area represented by the samples should be rejected. However, keep in mind that these samples are not to be included in the random samples for lot acceptance and pay factor adjustments. They pertain only to isolated areas. Only the test results of the random samples apply to the entire shift's production.

Plate Sampling

Four random plate samples are taken behind the laydown machine during each lot (shift) to determine the mix property pay factors. Samples must be 75 pounds minimum. It is important that samples are indeed taken "randomly" and that the Contractor is unaware ahead of time when the samples will be taken. Advance notice to the Contractor may defeat the purpose of random sampling. During an 8-hour shift, a mix sample should be taken in each 2-hour period on a random basis within that period. This is called “Stratified Random Sampling” and it is generally the best method for ensuring the most representative distribution of random samples. Stratified Random Sampling is not discussed in the 2000 ADOT Standard Specifications and therefore it is neither required nor prohibited. The choice to utilize this method must be made at the pre-paving meeting because any method used must be applied consistently and not switched to and from throughout the project. The Contractor shall have the necessary personnel on the site at all times during paving so samples can be taken on a moment's notice (20 minutes maximum notice is permissible). The Project Lab should have the samples promptly delivered to the acceptance lab (whether that is the regional lab, the central lab, or a consultant's lab).

Unless specified otherwise, the method of administering low tonnage lots, or lots where a sufficient number samples were not obtained should be mutually agreed upon with the Contractor. Options available include obtaining additional samples through coring or jack hammering, evaluating with n = 3, or combining lots with the next day’s production. Combining with the following day’s production is the most preferable choice.

The referee mixture-properties lot sample must be a split of the acceptance sample. The referee sample should not be taken from a separate plate. Extreme care should be taken in the handling, transporting and storage of referee samples.

ADOT must furnish acceptance test results to the contractor within four working days of receipt of the samples. The test results are reported to the Contractor as soon as they are available. This allows the Contractor to quickly correlate test results in order to produce the best pavement for the project. Occasionally, the acceptance lab (with the Resident Engineer's permission) may fax results directly to the Contractor and the Engineer at the same time.

416-7.03 Material Spread

The main difference between 416 and 406 is the requirement for spread lots. For spread compliance, a lot

represents a half shift of production; this is called a "spread lot." For compliance with the material properties of the asphalt mix itself, a lot represents an entire shift of production and is called a “mix-properties lot" in the specifications. The “mix-properties lot" is often called the "quality lot” in the field.

Under a spread lot, ADOT compares the actual amount of material placed versus the targeted amount that should have been placed. At the end of each spread lot, either the Project Supervisor or Lead Inspector should receive and review the Contractor's completed spread lot forms. These forms must be reviewed and approved on a daily basis. Do not wait until the end of the week, month, or project. Agreements should be reached on how much material was wasted, what areas are to be excluded from the spread, and how the material on any sloped edges will be handled.

Spread Control

Target values for the spread—pavement depths, widths, and lengths—should be agreed to before paving begins, so the target values can be calculated. The Inspector may occasionally check pavement thickness and width dimensions in the field to verify that target values are being met. Once the paving begins, the Contractor is responsible for controlling the spread and laydown operation. The Project Supervisor may exclude irregular areas from the spread. Irregular areas are defined as uneven surfaces where placing uniform depth of asphalt would be too difficult. Some gore and taper areas fit into this category where deep depressions exist due to severe rutting or subgrade settlement. While the spread gets more difficult to control as the existing surface becomes rough and irregular, the specifications can still be enforced on all but the roughest surface conditions. Conditions such as swelling clay areas may cause such a high degree of roughness to make the application of the spread specification impractical. One key method to avoiding problems in enforcing the specification is to explain carefully to the Contractor exactly how the day’s tonnage will be calculated. Exhibit 416-7.03-1 should be used by the Inspector to get a daily agreement on the spread quantities and penalties for each spread lot. Flexibility should be exercised in the interpretation of this specification so that the Contractor can expect to obtain compliance without minute-by-minute screed adjustments. The Resident Engineer can obtain permission to delete this portion of the specification if conditions warrant.

Asphaltic concrete is measured based on a day’s production including the quantities that were excluded from the spread lots or mix properties lots for irregular areas. Waste quantities, quantities in rejection, and quantities over the 5% spread limit are excluded from measurement. The AM and PM spread lots are usually combined to allow for unit price adjustments. Typically there are no price adjustments due to spread variations, since Contractors will avoid underrunning the spread. However, if there were a spread penalty, the AM and PM lots would have to be analyzed separately (see example calculation). Payments are best calculated on a daily production basis. Deductions or bonuses are calculated separately and added to the Contractor’s payment:

Placed Quantity x bid unit price	= initial amount owed to Contractor
AM Spread Quantity x AM spread pay factor	= AM spread price adjustment
PM Spread Quantity x PM spread pay factor	= PM spread price adjustment
Mix Prop Quantity x Mix prop pay factor	= Mix prop. price adjustment
Compaction Quantity x Comp. pay factor	= Comp. price adjustment
	_____
	Net amount paid to Contractor

The “placed quantity” is the amount of asphalt placed that day (from the weigh tickets) less any amounts wasted and less any amounts above the 5% spread quantity limit. This may be different than the mix property and compaction pay quantities if there are rumble strips or isolated areas the Resident Engineer elects to exclude from these lots (see subsection 416-9).

The calculations can become quite tedious since some quantities are not included for some types of lots (spread versus compaction for example) and excluded from others. A spreadsheet has been provided with this manual (see Exhibit 416-7.03-1) to assist the Field Office in making these calculations. Please keep these points in mind:

1. When a formed rumble strip is specified, the last lift placed on that shoulder is excluded from the compaction pay factor adjustments, but included in the spread and mix properties pay factors adjustments.

2. Irregular areas identified as being excluded from the AM or PM spread lots may or may not be excluded from the compaction lot and/or mix property lot quantities (check with the Project Supervisor or Resident Engineer).

3. Spread quantities that exceed the 5% spread limit are not included in any pay factor adjustments since the Department does not pay for them — this includes the asphalt cement and mineral admixture.

Example Calculation

A Contractor places 1,260 tons of asphaltic concrete in the morning and 1,460 tons in the afternoon. During the morning shift, 10 tons were wasted and the Inspector and the Contractor agreed to exclude an additional 25 tons from the spread lot, but include in the compaction and mix properties lots. During the afternoon, 15 tons were wasted and the Inspector determined that 750 tons were placed in a formed rumble strip area. Also, the Inspector calculated the theoretical spreads for the morning and afternoon to be 1,210 tons and 1,510 tons, respectively. The calculated PTs for that day's quality lot were done by the acceptance lab (with the respective pay factors taken from table 416-2 of the Standard Specifications).

	PT	PF (from Standard Specification Table 416-2)
3/8 inch sieve	75	-$0.50 (disregard - not the lowest)
No. 8 sieve	100	$0.00
No. 40 sieve	98	$0.00
No. 200 sieve	70	-$0.75 (lowest pay factor)
% asphalt cement	90	$0.00
% voids	97	+$0.50
Total Mix Pay Factor Adj.		-$0.25 (sum of voids plus lowest pay factor for sieve and % asphalt)
Compaction	95	+$0.50

If the Contractor's unit price for asphaltic concrete is $18 per ton, how much is owed to the Contractor for that day's production?

Solution

Compute the Spread Lot Pay Factors per 416-9(A) of the Standard Specifications:

AM Spread		PM Spread	
Batched	1260 tons	Batched	1460 tons
Waste	10	Waste	15
Placed	1250	Placed	1445
Excluded	25	Excluded	0
Net Spread	1225 tons	Net Spread	1445 tons
Calc. Spread	1210 tons	Calc. Spread	1510 tons
Yield	1.24% = $\frac{\text{net- calc.}}{\text{calc.}} \times 100$	Yield	-4.30%
Pay Factor (Std.Spec.Table 416-2)	$0.00	Pay Factor (Std.Spec.Table 416-2)	-$0.30
		Note: the rumble strip quantity is included in spread lot.	

Mix. Prop. Lot Quantity (416-9(B))	2695 ton (1250+1445)	PF =	-$0.25
Compaction Lot Quantity (416-9(C))	1945 ton (1250+1445-750)	PF =	$0.50

Calculate Pay Adjustments

	Quantity	Unit Price	Amount
Placed	2695	$18.00	$48,510.00
AM Spread	1225	$0.00	$0.00
PM Spread	1445	-$0.30	-$433.50
Mix Prop.	2695	-$0.25	-$673.75
Compaction	1945	$0.50	$972.50
Total Price Paid			$48,375.25

DETERMINATION OF LOT MATERIAL SPREAD QUANTITY REQUIRED AND PAY FACTOR FOR END PRODUCT METHOD OF ACCEPTANCE AND PAYMENT FOR AC

Project No. IM—010-C(9) / H999901C Type of Material ¾ inch AC

Date 7/30/01 Lot Number 3 AM

Calculation of Quantity Required (Tons)

Laboratory Mix Design Density = 142.2 pounds per cubic foot

Location	Station	to	Station	Length	*Width	Average Thick. (inch)	**Calculated Cubic Foot
WB	507+00		451+00	5600	16.5	1.5	11,550
						Total Calculated Cubic Foot in Lot =	11,550

Calculated Tons Required = $\frac{\text{(Total Calculated Cubic Foot in Lot) x (Lab Mix Design Density)}}{2000}$ = _____

= $\frac{(\ 11,500\ ) \times (\ 142.2\ )}{2000}$ = 817.6 ton

* For areas with varying widths, such as tapers, use average width

** Calculated Cubic Foot = (Length) x (Width) x $\frac{\text{(Average Thickness)}}{12}$

Actual Quantity Placed = 833.1 ton

% Variance from Quantity Reported = $\frac{\text{(Quantity Placed) - (Quantity Required)}}{\text{(Quantity Required)}}$ x 100 = ___%

= $\frac{(\ 833.1\ ) - (\ 817.6\ )}{(\ 817.6\ )}$ x 100= + 1.9 %

If the percent variance from the required quantity is more than 5.0%, no payment is made for material that exceeds 5.0% (record calculations and deductions for asphalt cement and mineral admixture in the Remarks area below). If the percent variance from the required quantity is +5.0% to -2.0%, no adjustment is made. If the percent variance from the required quantity is -2.1% to -12.0% the appropriate pay factor determined from Standard Specification Table 416-2 = _____

Std. Spec.Table 416-2

Pay Factors for Material Spread

Negative Variance %	Pay Factor (Dollar)
2.1 - 3.0	-0.10
3.1 - 4.0	-0.20
4.1 - 5.0	-0.30
5.1 - 6.0	-0.40
6.1 - 7.0	-0.50
7.1 - 8.0	-0.60
8.1 - 9.0	-0.70
9.1 - 10.0	-0.80
10.1 - 11.0	-0.90
11.1 - 12.0	-1.00

Remarks: *Ticket No. 319878 thru 320072 (3tons not used)*

Asphalt Cement Deduction (if applicable): _____ton Mineral Admix. Deduction (if applicable): _____ton

Contractor's Signature: _____ _____ Inspector's Signature: _____

Exhibit 416-7.03-1. Spread Determination Form

416-7.05 Compaction

For lifts of 1 ½'' or less the compaction of the AC follows a method specification and the inspector will have to monitor the temperatures and the rolling to ensure compliance with the specifications. Although there is no compaction lot in this case there will still be a quality lot that is to be evaluated by the 4 random plate samples.

For lifts greater than 1 ½'' there will be a compaction lot that is identical to the tonnage of the quality lot. The contractor is responsible for the compaction technique and the lot is evaluated statistically by end product methods. 20 cores will be taken from each lot at random locations. The 10 that are not used will be held for 15 days in case of a request for referee. After that time they must be discarded. Results will be furnished to the contractor within 5 working days of receipt of the samples.

Carefully review subsection 416-7.05(B) of the Standard Specifications before laying out the core locations. Inspectors must mark the exact core locations as calculated from the random numbers since bonuses and penalties are associated with the compaction core results. Furthermore, Inspectors should be watchful over the Contractor's coring operation so that the exact location specified is cored.

In addition to responsibility for compaction methods, the Contractor is responsible for the compaction characteristics of the mix design. Field personnel should not advise the Contractor on compaction procedures, so it will remain the Contractor's responsibility. The Inspector should not give implied (tacit) approval of any method.