REVISION OF SECTIONS 105 AND 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT
(LESS THAN 5000 TONS)

Sections 105 and 106 of the Standard Specifications are hereby revised for this project as follows:

Delete subsection 105.05 and replace with the following:

**105.05  Conformity to the Contract of Hot Mix Asphalt.**  Conformity to the Contract of all Hot Mix Asphalt, Item 403, except Hot Mix Asphalt (Patching) and temporary pavement will be determined by tests and evaluations of elements that include asphalt content, gradation,  in-place density and joint density in accordance with the following:

All work performed and all materials furnished shall conform to the lines, grades, cross sections, dimensions, and material requirements, including tolerances, shown in the Contract.

For those items of work where working tolerances are not specified, the Contractor shall perform the work in a manner consistent with reasonable and customary manufacturing and construction practices.

When the Engineer finds the materials or work furnished, work performed, or the finished product are not in conformity with the Contract and has resulted in an inferior or unsatisfactory product, the work or material shall be removed and replaced or otherwise corrected at the expense of the Contractor.

Materials will be sampled randomly and tested by the Department in accordance with Section 106 and with the applicable procedures contained in the Department's Field Materials Manual.  The approximate maximum quantity represented by each sample will be as set forth in Section 106.  Additional samples may be selected and tested as set forth in Section 106 at the Engineer's discretion.

A process will consist of either a single test value or a series of test values resulting from related tests of an element of the Contractor's work and materials.  An element is a material or workmanship property that can be tested and evaluated for quality level by the Department approved sampling, testing, and analytical procedures. All materials produced will be assigned to a process.  A change in process is defined as a change that affects the element involved.  For any element, with the exception of the process for joint density element, a process normally will include all produced materials associated with that element prior to a change in the job mix formula (Form 43).   For joint density, a new process will be established for each new layer of pavement or for changes in joint construction. Density measurements taken within each compaction test section will be a separate process. The Engineer may separate a process in order to accommodate small quantities or unusual variations.

Evaluation of materials for pay factors (PF) will be done using only the Department's acceptance test results. Each process will have a PF computed in accordance with the requirements of this Section. Test results determined to have sampling or testing errors will not be used.

Except for in-place density measurements taken within a compaction test section, any test result for an element greater than the distance 2 x V (see Table 105-2) outside the tolerance limits will be designated as a separate process and the pay factor will be calculated in accordance with subsection 105.05(a).  An element pay factor less than zero shall be zero.  The calculated PF will be used to determine the Incentive/Disincentive Payment (I/DP) for the process.

In the case of in-place density or joint density the Contractor will be allowed to core the exact location (or immediately adjacent location for joint density) of a test result more than 2 x V outside the tolerance limit. The core must be taken and furnished to the Engineer within eight hours after notification by the Engineer of the test result. The result of this core will be used in lieu of the previous test result.  Cores not taken within eight hours after notification by the Engineer will not be used in lieu of the test result.  All costs associated with coring will be at the Contractor s expense.

(a) *Representing Small Quantities.*  When it is necessary to represent a process by only one or two test results, PF will be the average of PFs resulting from the following:

REVISION OF SECTIONS 105 AND 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT
(LESS THAN 5000 TONS)

If the test result is within the tolerance limits then PF = 1.00

If the test result is above the maximum specified limit, then

$$PF = 1.00 - [0.25(T_O - T_U)/V]$$

If the test result is below the minimum specified limit, then

$$PF = 1.00 - [0.25(T_L - T_O)/V]$$

Where: 
PF = pay factor.
V = V factor from Table 105-2.
$T_O$ = the individual test result.
$T_U$ = upper specification limit.
$T_L$ = lower specification limit.

The calculated PF will be used to determine the I/DP for the process.

(b) *Determining Quality Level.* Each process with three or more test results will be evaluated for a quality level (QL) in accordance with Colorado Procedure 71.

(c) *Gradation Element.* Each specified sieve, with the exception of 100 percent passing sieves, will be evaluated for QL separately. The lowest calculated QL for a sieve will be designated as the QL for gradation element for the process.

(d) *Joint Density Element.* Joint Density will be tested according to subsection 401.17.

(e) *Process Pay Factor.* Using the calculated QL for the process, compute PF as follows: The final number of random samples (Pn) in each process will determine the final pay factor. . As test values are accumulated for each process, Pn will change accordingly. When the process has been completed, the number of random samples it contains will determine the computation of PF, based on Table 105-3 and formula (1) below. When Pn is from 3 to 9, or greater than 200, PF will be computed using the formulas designated in Table 105-3. Where Pn is equal to or greater than 10 and less than 201, PF will be computed by formula (1):

$$(1)\ PF = \frac{(PF_1 + PF_2)}{2} + \left[ \frac{(PF_2 + PF_3)}{2} - \frac{(PF_1 + PF_2)}{2} \right] \times \frac{(Pn_2 - Pn_X)}{(Pn_2 - Pn_3)}$$

Where, when referring to Table 105-3:
$PF_1$ = PF determined at the next lowest Pn formula using process QL
$PF_2$ = PF determined using the Pn formula shown for the process QL
$PF_3$ = PF determined at the next highest Pn formula using process QL
$Pn_2$ = the lowest Pn in the spread of values listed for the process Pn formula
$Pn_3$ = the lowest Pn in the spread of values listed for the next highest Pn formula
$Pn_X$ = the actual number of test values in the process

When evaluating the item of Furnish Hot mix asphalt, the PF for the element of In-Place Density shall be 1.0.

Regardless of QL, the maximum PF in relation to Pn is limited in accordance with Table 105-3.

REVISION OF SECTIONS 105 AND 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT
(LESS THAN 5000 TONS)

As test results become available, they will be used to calculate accumulated QL and PF numbers for each process.  The process I/DP's will then be calculated and accumulated for each element and for the item.  The test results and the accumulated calculations will be made available to the Contractor upon request.

Numbers from the calculations will be carried to significant figures and rounded according to AASHTO Standard Recommended Practice R-11, Rounding Method.

(f)  *Evaluation of Work.*  When the PF of a process is 0.75 or greater, the finished quantity of work represented by the process will be accepted at the appropriate pay factor.  If the PF is less than 0.75, the Engineer may:

1.  Require complete removal and replacement with specification material at the Contractor's expense;

    or

2.  Where the finished product is found to be capable of performing the intended purpose and the value of the finished product is not affected, permit the Contractor to leave the material in place.

If the material is permitted to remain in place the PF for the process will not be greater than 0.75.  When condition red, as described in Section 106, exists for any element, resolution and correction will be in accordance with Section 106.  Material, which the Engineer determines is defective, may be isolated and rejected without regard to sampling sequence or location within a process.

If removal and replacement is required because the joint density PF for a process is below 0.75, the Contractor shall remove and replace the full lane width adjacent to and including at least 6 inches beyond the visible joint line for the entire length of joint representing the process.  If the lane removed is adjacent to another joint, that joint shall also be removed to a point 6 inches beyond the visible joint line.  When a single joint density core is more than 2V outside the tolerance limits, the removal and replacement limits shall be identified by coring the failing joint at 25 foot intervals until two successive cores are found to be 1V or less below the minimum tolerance limit. If removal and replacement is required, the Contractor shall submit documentation identifying the process to be used to correct the area in question in writing.  The process will be approved by the Engineer before commencing the corrective work.

**Table 105-2**
**"W" AND "V" FACTORS FOR VARIOUS ELEMENTS**

| Hot Mix Asphalt | | |
|---|---|---|
| **Element** | **V Factor** | **W Factor** |
| 2.36 mm (No. 8) mesh and larger sieves | 2.80 | N/A |
| 600 µm (No. 30) mesh sieve | 1.80 | N/A |
| 75 µm (No. 200) mesh sieve | 0.80 | N/A |
| Gradation | N/A | 15 |
| Asphalt Content | 0.20 | 25 |
| In-place Density | 1.10 | 45 |
| Joint Density | 1.60 | 15 |

REVISION OF SECTIONS 105 AND 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT
(LESS THAN 5000 TONS)

**Table 105-3**
**FORMULAS FOR CALCULATING PF BASED ON PN**

| Pn | When Pn as shown at left is 3 to 9, or greater than 200, use designated formula below to calculate Pay Factor, PF = ..., when Pn is 10 to 200, use formula (1) above: | Maximum PF |
|---|---|---|
| 3 | $0.31177 + 1.57878 (QL/100) - 0.84862 (QL/100)^2$ | 1.025 |
| 4 | $0.27890 + 1.51471 (QL/100) - 0.73553 (QL/100)^2$ | 1.030 |
| 5 | $0.25529 + 1.48268 (QL/100) - 0.67759 (QL/100)^2$ | 1.030 |
| 6 | $0.19468 + 1.56729 (QL/100) - 0.70239 (QL/100)^2$ | 1.035 |
| 7 | $0.16709 + 1.58245 (QL/100) - 0.68705 (QL/100)^2$ | 1.035 |
| 8 | $0.16394 + 1.55070 (QL/100) - 0.65270 (QL/100)^2$ | 1.040 |
| 9 | $0.11412 + 1.63532 (QL/100) - 0.68786 (QL/100)^2$ | 1.040 |
| 10 to 11 | $0.15344 + 1.50104 (QL/100) - 0.58896 (QL/100)^2$ | 1.045 |
| 12 to 14 | $0.07278 + 1.64285 (QL/100) - 0.65033 (QL/100)^2$ | 1.045 |
| 15 to 18 | $0.07826 + 1.55649 (QL/100) - 0.56616 (QL/100)^2$ | 1.050 |
| 19 to 25 | $0.09907 + 1.43088 (QL/100) - 0.45550 (QL/100)^2$ | 1.050 |
| 26 to 37 | $0.07373 + 1.41851 (QL/100) - 0.41777 (QL/100)^2$ | 1.055 |
| 38 to 69 | $0.10586 + 1.26473 (QL/100) - 0.29660 (QL/100)^2$ | 1.055 |
| 70 to 200 | $0.21611 + 0.86111 (QL/100)$ | 1.060 |
| $\geq 201$ | $0.15221 + 0.92171 (QL/100)$ | 1.060 |

(g) *Process I/DP Computation.*

$$I/DP = (PF - 1)(QR)(UP)(W/100)$$

Where:
| | | |
|---|---|---|
| I/DP | = | Incentive/Disincentive Payment |
| PF | = | Pay Factor |
| QR | = | Quantity in Tons of HMA Represented by the Process |
| UP | = | Unit Bid Price of Asphalt Mix |
| W | = | Element Factor from Table 105-2 |

When AC is paid for separately UP shall be:

$$UP = [(Ton_{HMA})(UP_{HMA}) + (Ton_{AC})(UP_{AC})]/Ton_{HMA}$$

Where:
| | | |
|---|---|---|
| $Ton_{HMA}$ | = | Tons of Asphalt Mix |
| $UP_{HMA}$ | = | Unit Bid Price of Asphalt Mix |
| $Ton_{AC}$ | = | Tons of Asphalt Cement |
| $UP_{AC}$ | = | Unit Bid Price of Asphalt Cement |

For the joint density element:

$$UP = UP_{HMA}$$

Where: $UP_{HMA}$ is as defined above.

When AC is paid for separately UP shall be:

$$UP = [(BTon_{HMA})(BUP_{HMA}) + (BTon_{AC})(BUP_{AC})]/BTon_{HMA}$$

Where:

| | | |
|---|---|---|
| $BTon_{HMA}$ | = | Bid Tons of Asphalt Mix |
| $BUP_{HMA}$ | = | Unit Bid Price of Asphalt Mix |
| $BTon_{AC}$ | = | Bid Tons of Asphalt Cement |
| $BUP_{AC}$ | = | Unit Bid Price of Asphalt Cement |

(h) *Element I/DP.* The I/DP for an element shall be computed by accumulating the process I/DP's for that element.

(i) *I/DP for a Mix Design.* The I/DP for a mix design shall be computed by accumulating the individual I/DP's for the asphalt content, in-place density, and gradation elements for that mix design. The accumulated quantities of materials for each element must be the same at the end of I/DP calculations for a mix design.

(j) *Project I/DP.* The I/DP for the project shall be computed by accumulating the mix design I/DP's and the joint density I/DP's. The accumulated quantities of materials for each element must be the same at the end of I/DP calculations for the project.

Delete subsection 106.05 and replace with the following:

**106.05 Sampling and Testing of Hot Mix Asphalt.** All hot mix asphalt, Item 403, except Hot Mix Asphalt (Patching) and temporary pavement shall be tested in accordance with the following program of process control testing and acceptance testing:

The Contract will specify whether process control testing by the Contractor is mandatory or voluntary.

(a) *Process Control Testing.*

1. Mandatory Process Control. When process control testing is mandatory the Contractor shall be responsible for process control testing on all elements and at the frequency listed in Table 106-1. Process control testing shall be performed at the expense of the Contractor.

   After completion of compaction, in-place density tests for process control shall be taken at the frequency shown in Table 106-1. The results shall be reported in writing to the Engineer on a daily basis. Daily plots of the test results with tonnage represented shall be made on a chart convenient for viewing by the Engineer. All of the testing equipment used for in-place density testing shall conform to the requirements of acceptance testing standards, except nuclear testing devices need not be calibrated on the Department's calibration blocks.

   For elements other than in-place density, results from quality control tests need not be plotted, or routinely reported to the Engineer. This does not relieve the Contractor from the responsibility of performing such testing along with appropriate plant monitoring as necessary to assure that produced material conforms to the applicable specifications. Quality control test data shall be made available to the Engineer upon request.

2. Voluntary Process Control. The Contractor may conduct process control testing. Process control testing is not required, but is recommended on the elements and at the frequency listed in Table 106-1.

REVISION OF SECTIONS 105 AND 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT
(LESS THAN 5000 TONS)

All of the testing equipment used for in-place density testing shall conform to the requirements of acceptance testing standards, except nuclear testing devices need not be calibrated on the Department's calibration blocks.

(b) *Acceptance Testing.* Acceptance testing is the responsibility of the Department. For acceptance testing the Department will determine the locations where samples or measurements are to be taken and as designated in Section 403. The maximum quantity of material represented by each test result, the elements, the frequency of testing and the minimum number of test results will be in accordance with Table 106-1. The location or time of sampling will be based on the stratified random procedure as described in CP 75. Acceptance sampling and testing procedures will be in accordance with the Schedule for Minimum Materials Sampling, Testing and Inspection in the Department's Field Materials Manual. Samples for project acceptance testing shall be taken by the Contractor in accordance with the designated method. The samples shall be taken in the presence of the Engineer. Where appropriate, the Contractor shall reduce each sample to the size designated by the Engineer. The Contractor may retain a split of the each sample which cannot be included as part of the Contractor's process control testing. All materials being used are subject to inspection and testing at any time prior to or during incorporation into the work.

**Table 106-1**
**SCHEDULE FOR MINIMUM SAMPLING AND TESTING**

| Element | Process Control | Acceptance |
|---|---|---|
| Asphalt Content | 1/500 tons | 1/1000 tons |
| Theoretical Maximum Specific Gravity | 1.1000 tons, minimum 1/day | 1/1000 tons, minimum 1/day |
| Gradation | 1/Day | 1/2000 tons |
| In-Place Density | 1/500 tons | 1/500 tons |
| Joint Density | 1 core/2500 linear feet of joint | 1 core /5000 linear feet of joint |
| Aggregate Percent Moisture (3) | 1/2000 tons or 1/Day if less than 2000 tons | 1/2000 tons |
| Percent Lime (3) (4) | 1/Day | Not applicable |

Notes:
(1) The minimum number of in-place density tests for acceptance will be 5.

(2) Process control tests for gradation are not required if less than 250 tons are placed in a day. The minimum number of process control tests for gradation shall be one test for each 1000 tons or fraction thereof.

(3) Not to be used for incentive/disincentive pay. Test according to CP 60B and report results from Form 106 or Form 565 on Form 6.

(4) Verified per Contractor's QC Plan.

REVISION OF SECTIONS 105 AND 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT
(LESS THAN 5000 TONS)

(c) *Reference Conditions.* Three reference conditions can exist determined by the Moving Quality Level (MQL). The MQL will be calculated in accordance with the procedure in CP 71 for Determining Quality Level (QL). The MQL will be calculated using only acceptance tests. The MQL will be calculated on tests 1 through 3, then tests 1 through 4, then tests 1 through 5, then thereafter on the last five consecutive test results. The MQL will not be used to determine pay factors. The three reference conditions and actions that will be taken are described as follows:

1. Condition green will exist for an element when an MQL of 90 or greater is reached, or maintained, and the past five consecutive test results are within the specification limits.

2. Condition yellow will exist for all elements at the beginning of production or when a new process is established because of changes in materials or the job-mix formula, following an extended suspension of work, or when the MQL is less than 90 and equal to or greater than 65. Once an element is at condition green, if the MQL falls below 90 or a test result falls outside the specification limits, the condition will revert to yellow or red as appropriate.

3. Condition red will exist for any element when the MQL is less than 65. The Contractor shall be notified immediately in writing and the process control sampling and testing frequency increased to a minimum rate of 1/250 tons for that element. The process control sampling and testing frequency shall remain at 1/250 tons until the process control QL reaches or exceeds 78. If the QL for the next five process control tests is below 65, production will be suspended.

   If gradation is the element with MQL less than 65, the Department will test one randomly selected sample in the first 1250 tons produced in condition red. If this test result is outside the tolerance limits, production will be suspended. (This test result will not be included as an acceptance test.)

   After condition red exists, a new MQL will be started. Acceptance testing will stay at the frequency shown in Table 106-1. After three acceptance tests, if the MQL is less than 65, production will be suspended.

   Production will remain suspended until the source of the problem is identified and corrected. Each time production is suspended, corrective actions shall be proposed in writing by the Contractor and approved in writing by the Engineer before production may resume.

   Upon resuming production, the process control sampling and testing frequency for the elements causing the condition red shall remain at 1/250 tons. If the QL for the next five process control tests is below 65, production will be suspended again. If gradation is the element with MQL less than 65, the Department will test one randomly selected sample in the first 1250 tons produced in condition red. If this test result is outside the tolerance limits, production will be suspended.