OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
FOR
QUALITY CONTROL AND ACCEPTANCE PROCEDURES FOR
ASPHALT CONCRETE PAVEMENTS

These Special Provisions revise, amend, and where in conflict, supersede applicable sections of the 1999 Standard Specifications for Highway Construction, English and Metric. Units of measurement are provided in the subsections in both English and Metric equivalents. The units for this project shall be those specified in the project plans. These Special Provisions apply to all types of Asphalt Concrete Pavement.

(add the following:)

411.01 DESCRIPTION.

Contractors Quality Control and Acceptance Procedures will apply to all asphalt as herein specified.

411.04 CONSTRUCTION METHODS.

(m) **Contractor's Quality Control Testing and Inspection**. The Contractor shall provide quality control personnel as necessary to assure the production of quality products as specified. Such personnel shall include one or more Quality Control Technicians who either individually or collectively are fully qualified in the production, placement and testing of plant mix asphalt concrete. Sampling and/or testing of construction materials for either control or acceptance purposes shall be accomplished by persons certified in the appropriate area(s) by the Oklahoma Highway Construction Materials Technician Certification Board.

The Contractor shall be responsible for the formulation of all mix designs. The mix design shall be prepared by an approved asphalt mix design laboratory of the Contractor's choice. All mix designs and changes to the mix designs shall be submitted to the Materials Engineer for review. The Contractor shall perform or have performed all field sampling and testing necessary to ensure that materials and products are within the specified acceptable range. Control charts displaying results of these tests shall be maintained by the Contractor and displayed at the plant site. Copies of the Contractor's quality control tests shall be provided to the Engineer within 24 hours or at time intervals acceptable to the Engineer. Certification by the manufacturers may be used in lieu of field tests when such tests in the field are impracticable. Asphalt cement and additives are examples of materials in this category.

(1) *Contractor's Process Control.* The Contractor shall be responsible for the process control of all materials during handling, blending, mixing and placing operations to produce an acceptable asphalt concrete.

At no time will the Engineer issue instructions to the Contractor or producer as to the setting of dials, gauges, scales and meters. However, he/she may advise the Contractor against the continuance of any operations or sequence of operations which will result in non-compliance with Specification requirements.

(2) *Contractor's Testing.* For the four characteristics subject to pay adjustments in this Special Provision, the Contractor's sampling and testing shall, as a minimum, comply with the schedule in paragraph (n)(12) "Contractor's Testing and Engineer's Acceptance Procedures". Additional sampling and testing to ensure compliance with Standard Specifications and other Special Provision requirements shall be in accordance with the Contractor's Quality Control Plan.

(3) *Contractor's Laboratory.* The Contractor shall provide a fully equipped laboratory at a location no more than 50 road miles from the production site. The laboratory shall be subject to approval of the Engineer.

(4) *Contractor's Quality Control Plan.* Prior to initiation of work, the Contractor shall prepare a plan to ensure that acceptable quality can and will be obtained. The plan, which is to be submitted to the Engineer at least one week prior to the prework conference, shall comply with SP 643-6QA and cover all of the items discussed in Section 411 and 708 of the Standard Specifications. However, the Contractor must tailor the plan to meet specific needs

of the project. Once accepted by the Engineer, the plan becomes a part of the Contract and shall be enforced accordingly. Subsequent changes to the plan may be required by the Engineer in order to adjust to changes in the process or to correct problems in meeting Specification requirements.

(5) *Identifying Testing Precision and Bias.* For each test characteristic of each contract item for which control charting is required, the following initialization procedure shall be performed:

5.1 Initial testing shall be performed to identify any testing biases between the Contractor's and the Department's testing equipment and procedures. This testing will be referred to as "initialization" testing and will include the plant startup testing as well as the first lot for each contract item for which control charting is required. In all instances, technician- and equipment-identification numbers shall be recorded with each test result to assist in troubleshooting potential testing discrepancies.

5.2 The frequency of testing for initialization lots shall be double the normally-specified testing frequency. As such, each initialization lot shall be broken down into ten (10) equal sublots with the sampling within each sublot to be performed at a random location or time interval in accordance with ASTM D 3665 or other acceptable means for ensuring random sampling of the materials.. Optionally, the Engineer and Contractor can agree to use the 10 test results from two lots rather than doubling the sublots where 10 test results for one lot is specified for initialization comparisons.

5.3 During the initialization testing, for each sublot, the Contractor shall obtain fresh asphalt concrete samples in accordance with AASHTO T 168 under direct observation by the Engineer (for subsequent air voids, asphalt cement content, and gradation testing). The samples shall be split into four (4) equal parts according to AASHTO T 248. The Contractor and the Department shall each perform the following tests (all from the same "split" sample of asphalt concrete): one(1) air voids tests; one(1) asphalt cement content tests; one(1) set of gradation sieve analyses.

5.4 During the initialization testing, for each sublot, the Contractor shall obtain a roadway density core from three(3) randomly-selected locations. At each location, one(1) core shall be obtained and tested by each lab. Each of the three (3) locations shall be considered as one test for density. Furthermore, if nuclear-methods for determining roadway density are to be used on the project, four (4) two-minute minimum nuclear density measurements shall be taken directly over each coring location prior to coring and without moving the gauge between readings. Each core shall be uniquely identified to enable direct comparisons with each lab and, if applicable, with the nuclear density measurements. The four (4) nuclear density results shall be averages and reported as the test result after a check for outliers.

5.5 During initialization testing, the Contractor and the Engineer shall not divulge their respective test results until the conclusion of all sampling and associated testing for a given lot and quality characteristic. Trial batch and test section tests results may be disclosed.

5.6 At the conclusion of the sampling and associated testing for a given initialization lot and quality characteristic, a statistical "paired-t test" will be performed by the Engineer (in accordance *Appendix A, Use of Contractor's Test Results for Acceptance Purposes*) on each characteristic using the pairs of initialization test data (which should include at least ten (10) pairs each for air voids, asphalt cement content, roadway density, and each gradation sieve.) The Engineer may, at his discretion, exclude from this and subsequent analyses any initialization test data that are clearly due to explainable special-cause variation provided the cause of said variation has been corrected so as to be unlikely to reoccur.

5.7 For those characteristics showing a *statistically* and *practically* significant bias between the Contractor's and the Department's test methods, the following shall govern:

5.7.1 The Department's test results shall be relied upon for acceptance and pay adjustment until such time as:

5.7.1.1 the source of the bias has been identified and eliminated and the lack of bias subsequently validated in accordance with the Department's Construction Control Directive on *Use of Contractor's Test Results for Acceptance Purposes*, or

5.7.1.2 as provided in Subsection 5.7.2 below

5.7.2 The Contractor may request evaluation of the testing bias via side-by-side three-way testing with an independent-assurance laboratory. In this instance, the following shall govern:

5.7.2.1 The Department will select the independent-assurance laboratory, which may be the Department's own independent-assurance laboratory or a third-party laboratory of the Department's choosing.

5.7.2.2 The steps outlined in Subsection 5.2. through 5.5. shall be performed utilizing three-way split samples, with the Contractor, Department, and independent-assurance laboratory each performing tests on the split-sample specimens.

5.7.2.3 At the conclusion of the three-way split-sample testing, three statistical "paired-t tests" will be performed by the Engineer (in accordance with the Department's Construction Control Directive on *Use of Contractor's Test Results for Acceptance Purposes*) using the three pairs of evaluation test data (e.g. Contractor's versus Department's, Contractor's versus independent-assurance laboratory's, and Department's versus independent-assurance laboratory's test results).

5.7.2.4 If either of the following conditions are identified as a result of a three way split-sample testing and analysis, Subsection 5.7.2.6 shall govern, otherwise subsection 5.7.2.5 shall govern :

(i) There is no *statistically*- **and** *practically*-significant bias between the Contractor's test methods and the independent-assurance laboratory's test methods, or

(ii) the test methods employed by the Contractor during three way split-sample testing are not representative of the test methods to be employed by the Contractor during the normal execution of the project.

5.7.2.5 The following shall govern subject to Subsection 5.7.2.4:

(i) The Contractor shall not be held responsible for any additional costs incurred by the Department in conjunction with the three-way split-sample testing.

(ii) The Contractor's test results shall be relied upon for acceptance and pay adjustment subject to the provisions of Subsection 5.8.

5.7.2.6 The following shall govern subject to Subsection 5.7.2.4:

(i) The Contractor shall reimburse the Department for all additional costs incurred by the Department as a result of the three-way split-sample testing.

(ii) The Department's test results shall be relied upon for acceptance and pay adjustment in accordance with Subsection 5.7.1.1.

5.8 **For those characteristics where the statistical paired-t test validates the Contractor's test methods, the Contractor's test results will be used for acceptance and pay adjustment subject to the following:**

5.8.1 The Engineer will perform ongoing paired testing at the approximate frequency of one (1) paired test per lot, but not less than one (1) paired test for every ten (10) sublots.

5.8.2 The Engineer will keep and maintain testing-bias control charts in

accordance with the Appendix A on *Use of Contractor's Test Results for Acceptance Purposes*.

5.8.3 In the event the Engineer's testing-bias control charts demonstrate an out-of-control condition for testing bias, the following procedures shall be followed:

5.8.3.1 The Contractor and Engineer shall immediately investigate the probable cause.

5.8.3.2 If the probable cause is identified and corrected or if the resulting bias is (according to the judgment of the Engineer) not likely to exceed the limits for Allowable Systemic Testing Bias (ASTB) set forth in the Appendix A on *Use of Contractor's Test Results for Acceptance Purposes*,

(i) Acceptance and pay adjustments for that quality characteristic will continue to be based on the Contractor's test results.

(ii) At the Engineer's discretion, the errant test results may be discarded from the acceptance and pay-adjustment calculations. If replacement test results are available (i.e. Department tests were performed on the same sublots as the discarded Contractor test results) the Department's test results may, at the Engineer's discretion, be substituted for the discarded test results.

5.8.3.3 If the probable cause is not corrected and the resulting bias is (according to the judgment of the Engineer) likely to exceed the limits for Allowable Systemic Testing Bias (ASTB) set forth in the Department's Construction Control Directive on *Use of Contractor's Test Results for Acceptance Purposes*,

(i) All subsequent testing for that quality characteristic will be paired testing until such time as the source of the unacceptable testing bias is clearly identified and corrected and the validity of the Contractor's test methods has been re-established.

(ii) During this period of 100% paired testing, acceptance and pay adjustments for that quality characteristic will be based on the Department's test results rather than the Contractor's.

(6) *Control Charts for Quality Control.* The Contractor shall maintain and keep current control charts covering, as a minimum, the characteristics of air voids, asphalt cement content, gradation (for each sieve), and roadway density. In all instances, technician and equipment identification numbers shall be recorded with each test to assist in troubleshooting potential testing discrepancies.

6.1 The control charts shall be "individuals" or "individuals and moving range" (I&MR) type control charts or as otherwise approved by the Engineer.

6.2 The charts shall identify the project number; the contract item number; the characteristic being measured; the date, time, lot #, sublot #, technician identification # and equipment identification # for each measurement; the applicable upper and lower control limits (but NOT the specification limits); the Contractor's test results; and any other data needed to facilitate control of the process and identify out-of-control conditions for the process in a timely manner.

6.3 The centerline, standard deviation, and upper and lower control limits for each control chart shall initially be calculated based on the initialization test results for each characteristic and contract item, excluding any initialization test results clearly due to explainable special-cause variation. Written approval by the Engineer will be required prior to any such exclusion of test data.

6.4 An "out of control" condition is defined as the condition resulting from any one of the following eight (8) "alarm" conditions occurring on a single control chart:

6.4.1 Any one point is more than 3 standard deviations from the centerline.
6.4.2 Nine points in a row are on the same side of the centerline.
6.4.3 Six points in a row are all increasing or all decreasing.
6.4.4 Fourteen points in a row are alternating up and down.
6.4.5 Two out of three points are more than 2 standard deviations from the centerline (and on the same side of the centerline).
6.4.6 Four out of five points are more than 1 standard deviation from the centerline (and on the same side of the centerline).
6.4.7 Fifteen points in a row are all within 1 standard deviation of the centerline.
6.4.8 Eight points in a row are all more than 1 standard deviation from the centerline (on either side of the centerline).

6.5 Whenever an out-of-control condition corresponding to alarm criteria 6.4.1, 2, 3, 5, 6 or 8 is observed for any of the control charts, the Contractor shall provide written notification to the Engineer concerning said out-of-control condition within 18 hours of the time the alarm-generating test was performed. In addition, the Contractor shall provide written notification to the Engineer (within 36 hours of the time the alarm-generating test was performed) concerning the investigative and/or corrective actions taken or to be taken. **Failure to provide written notification to the Engineer within the time periods specified shall result in an automatic one-half-percent reduction in the composite pay factor for the affected lot for each failure to comply with the specified notification procedures.** After the probable-cause investigation for the out-of-control condition has been completed, written notification shall be provided to the Engineer stating the probable cause and corrective actions taken or to be taken to reduce the likelihood of reoccurrence (or, stating that the probable cause could not be determined, if such is the case). The Engineer may, at his discretion, exclude from pay-adjustment calculations any out-of-control test data for which the special-cause variation has been adequately identified and explained, provided the cause of said variation has been corrected so as to be unlikely to reoccur. (NOTE: Not all out-of-control conditions will require corrective action. For example, a change in roadway densities due to a change in rolling pattern may not require corrective action if the densities being obtained remain safely within the specified limits. However, all out-of-control conditions shall be investigated for probable cause, regardless of the proximity of the measured values to the specification limits.)

6.6 In the event a significant change to the process occurs or is observed (e.g. change in raw material sources, change in mix proportions, steady drift in roadway densities, etc.), the control limits (including centerline and standard deviation) for the affected characteristics shall be recalculated using the available test data that best represent the new process. Any such changes to control limits must be approved in writing by the Engineer.

(n) **Acceptance.** While the Contractor shall be fully and exclusively responsible for producing an acceptable product, acceptance responsibility rests with the Engineer. The entire lot of asphalt as defined in paragraph (n) (12) "Lot and Sublot Selection" will be accepted or rejected and paid for on the basis of acceptance test results.

(1) *General.* The following characteristics will be considered when determining the acceptability and pay factors for Plant Mix Asphalt Concrete Pavement. However, all of the requirements of the Standard Specifications on materials and workmanship except those superseded by Special Provisions in this Contract, shall remain in effect.

(a) Asphalt Cement Content
(b) Gradation
(c) Air Voids
(d) Roadway Density

Several methods are available to test for the above characteristics. While only one method

will be used, several tests may be made to measure each characteristic. The pay factors that relate to gradation will be considered in a group with only the lowest pay factor for the individual sieves to be considered in determining payment. (All sieves specified in Section 708.04 of the Standard Specifications or as modified by Special Provisions in this Contract shall be run.) The remaining applicable pay factors will be considered individually in determining payment. Pay factors for asphalt cement content, gradation (lowest), air voids, and roadway density will apply to all asphalt concrete placed.

(2) *Criteria for Lot Acceptance and Payment*. Except for surface smoothness, conformance with the specifications will be judged on the basis of the following criteria:

2.1 The estimated Percent-within-Limits (PWL) with respect to gradation, asphalt cement content, air voids, and roadway density. The PWL with respect to a particular quality characteristic is the amount of materials and construction which falls within the specified limits listed in the following tables (where "JMF" refers to the corresponding values from the Job Mix Formula):

Quality Characteristic	**Lower Specification Limit (LSL)**	**Upper Specification Limit (USL)**
Gradation:		
Sieves #4 and larger	JMF – 6.0 %	JMF + 6.0 %
Sieves #8 through #100	JMF – 4.5 %	JMF + 4.5 %
Sieve # 200	JMF – 2.0 %	JMF + 2.0 %
Asphalt Cement Content	JMF – 0.4 %	JMF + 0.4%
Air Voids (lab molded)	JMF[1] – 1.25 %	JMF[1] + 1.25 %
Roadway Density	93%	97%

Quality Characteristic	**Lower Target Limit (LTL)**	**Upper Target Limit (UTL)**
Gradation:		
Sieves #4 and larger	JMF – 2.5 %	JMF + 2.5 %
Sieves #10 through #80	JMF – 1.8 %	JMF + 1.8 %
Sieve # 200	JMF – 0.8 %	JMF + 0.8 %
Asphalt Cement Content	JMF – 0.16 %	JMF + 0.16 %
Air Voids (lab molded)	JMF[1] – 0.5 %	JMF[1] + 0.5 %
Roadway Density	94%	96%

1) Note: JMF=(100 - mid-point of density range shown on the mix design) e.g. JMF for NMS mixtures, 100-96=4.

(3) *Acceptable and Rejectable Quality Levels*. A lot shall be considered of acceptable quality with respect to a particular characteristic if the PWL, as defined in Subsection (n)(2) is no less than 90 percent. A lot shall be considered of rejectable quality with respect to a particular characteristic if the PWL, as defined in Subsection (n)(2), is less than 50 percent. Lots exceeding the Acceptable Quality Level shall be subject to positive pay adjustments as defined in Subsection (n)(5). Lots failing to achieve the Acceptable Quality Level but exceeding the Rejectable Quality Level shall be subject to negative pay adjustments as defined in Subsection (n)(5). Lots failing to achieve the Rejectable Quality Level in one or more characteristic shall be subject to removal and replacement or zero pay (at the discretion of the Engineer).

The contractor shall perform the necessary quality-control sampling and testing to ensure that acceptable quality level requirements are consistently met.

(4) *Determination of Percent-within-Limits (PWL)*. The PWL with respect to each of the characteristics of gradation, asphalt content, air voids, and roadway density, will be determined as follows:

4.1 Compute the sample mean ($\overline{X}$) and the sample standard deviation (S') of the N = 5 test results (X_i):

$$\overline{X} = \frac{\sum X_i}{N} \qquad S' = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \overline{X})^2}{N-1}}$$

4.2 If $\overline{X}$ falls outside the target limits (LTL and UTL) **and** inside the specification limits (LSL and USL), compute the target-adjusted standard deviation (S'') as follows:

$$S'' = \sqrt{S'^2 + (X_{target} - \overline{X})^2}$$

where X_{target} = the nearest target limit (LTL OR UTL)

4.3 If $\overline{X}$ falls inside the target limits (LTL and UTL) or outside the specification limits (LSL and USL), compute the target-adjusted standard deviation (S'') as follows:

$$S'' = S'$$

4.4 Using the target-adjsuted standard deviation (S''), compute the upper quality index (Q_u) and the lower quality index (Q_L) corresponding to the upper and lower specification limits listed in Subsection (n) (2):

$$Q_U = \frac{USL - \overline{X}}{S''} \qquad Q_L = \frac{\overline{X} - LSL}{S''}$$

4.5 Using Table 1 (for sample size N=5 or the appropriate table for other values of N), determine the percentage of materials and construction falling outside the specification limits PD_U and PD_L associated with Q_U and Q_L, respectively. Add these two values to obtain the lot percent defective (PD):

$$PD = PD_U + PD_L$$

4.6 Determine the percentage of materials and construction falling within the specification limits *PWL* as follows:

$$PWL = 100 - PD$$

(5) *Pay Factors for Lot Quality* Characteristics. Except for pavement smoothness, the pay factor (PF) for each quality characteristic will be determined as follows:

5.1 If *PWL* is greater than or equal to 50 percent, compute the pay factor using the equation:

$$PF = 3.24(PWL) - 0.016(PWL)^2 - 62$$

5.2 If PWL is less than 50 percent, the Engineer may require removal and replacement of the defective lot at the Contractor's expense. If this option is not exercised, the

Contractor may elect to replace the lot or leave it in place subject to a pay factor (for that quality characteristic) of PF = 0%.

(6) *Pay Adjustment for Lots*. Once a lot has been defined, it's identity will be maintained throughout the mixing and placement process. When the lot is completed, the individual pay factors determined in Subsection (n) 2.1 for gradation, asphalt content, air voids, and roadway density will be used to calculate a composite pay factor (CPF) and a pay adjustment (PA) for the subject lot as follows:

$$CPF = \frac{4PF_D + 3PF_V + 2PF_A + PF_G}{10}$$

where:

PF_A = Pay factor for asphalt content,
PF_V = Pay factor for air voids,
PF_D = Pay factor for roadway density, and
PF_G = Pay factor for gradation – the smallest of the individual pay factors for the sieves listed in Subsection (n) 2.1.

The pay adjustment for the completed lot will be determined in accordance with the following formula:

$$PA_{Lot} = (CPF - 1)(CUP)(Q_{Lot})$$

where:

PA_{Lot} = Pay adjustment for the lot,
CPF = Composite pay factor,
CUP = Contract unit price ($/Ton ($/Metric Ton)), and
Q_{Lot} = Quantity of asphalt concrete in the lot (Tons (Metric Tons))

(7) *Smoothness Acceptance and Pay Adjustment.* For smoothness determination and pay adjustment purposes, the pavement surface will be tested on an extent-to-extent basis in accordance with Special Provisions 430-1QA. Acceptance and pay adjustment determinations made under Special Provisions 430-1QA will be completely independent of those made under this Special Provision.

(8) *Pay Adjustments Not Covered in Special Provisions 411-9QA or 430-2QA.* Adjustments in pay, for deviations from specified standards for characteristics other than those described in these Special Provisions (if any) will be made in accordance with General Provision 105.03.

(9) *Total Pay Adjustment for Entire Project.* The total adjustment in pay for the entire project is the sum of: (1) the pay adjustments for individual lots per Subsection (n)(6); plus (2) the pay adjustments for smoothness per Special Provision 430-2QA; plus (3) other pay adjustments, if appropriate, per Subsection (n)(8).

(10) *Extreme Values (Outliers).* Test results apparently inconsistent with the results of the majority of test will also be closely examined by the Engineer in order to determine their validity. The examination will cover the procedures used in sampling and testing and , if necessary, a mathematical analysis performed in accordance with ASTM E 178 (upper 2.5% significance level). Test results thus determined by the Engineer to be non-representative of the material being evaluated will be discarded. The remaining test results will then be supplemented, if necessary.

(11) *Lot and Sublot Section.* The asphalt concrete will be randomly sampled and tested for all control test characteristics on a lot to lot basis in accordance with the following requirements.

However, any load of mixture which is visually unacceptable for reasons of being excessively segregated or aggregate improperly coated will be rejected for use in the work. Excessively high or low temperature will be cause for rejection. Furthermore, sections of completed pavement which form visual observation or known deficiencies that appear to be seriously inadequate will be tested. The results of such tests will not be used for pay adjustment purposes but will be used to determine whether the section is totally unacceptable and must be removed. In the event that it is determined to be unacceptable, its removal and replacement shall be at no additional cost to the Department. A standard size lot at the asphalt plant shall consist of five (5) equal sublots of 1,000 tons (metric tons) each. Any partial lot (one with less than 5,000 tons (metric tons)) shall be treated as a separate lot when four (4) or more sublots exist. When a lot contains three (3) or less sublots, it shall be combined with the previous lot. On multiple project contract, the lots of the asphalt will carry over from project to project within that contract. All acceptance testing shall be performed at a random location or time interval within each sublot in accordance with ASTM D 3665 or other acceptable means for ensuring random sampling of the materials.

(12) *Contractor's Testing and Engineer's Acceptance Procedures*. Once a lot has been defined, its identity will be maintained throughout the mixing and placement process. Pay factors, determined from random sampling and testing the lot at appropriate locations will be used in computing its pay adjustment.

The Contractor is required as a minimum to comply with the following schedule for sampling and testing. Depending upon the available time and his confidence in the Contractor's Process Control, the Engineer may elect to perform more or less sampling and testing.

Asphalt Cement Content and Gradation - one (1) specimen randomly selected per sublot.

Air voids (except NMS mixes) - one (1) test per sublot randomly selected. Three (3) specimens shall be averaged and considered as one (1) test.

Air voids (NMS mixes) - one (1) test per sublot randomly selected. Two (2) specimens shall be averaged and considered as one (1) test.

Roadway Density - three (3) specimens per sublot randomly selected and considered as three (3) tests.

(o) **Plant Startup Requirements.** Prior to beginning production of asphalt for the mainline the Contractor shall provide a quality control system. The system shall include the fully equipped laboratory and the full complement of quality control personnel that are to perform the quality control functions of the remainder of the project.

Plant startup production shall be limited to that necessary to calibrate the plant and the testing equipment and procedures using the mix design approved for mainline construction. The asphalt concrete thus produced shall be sampled and tested by both the Contractor and the Engineer for VMA, Hveem Stability (when applicable) and all of the characteristics except roadway density. The Contractor's test results shall then be reconciled with those from the Engineer.

No asphalt concrete from the startup operation shall be placed on the mainline or the control strip. Instead, adjustments shall continue to be made until all of the requirements are met. Asphalt concrete from the plant startup operation may be utilized and paid for in the construction of temporary facilities or if no temporary facilities are available they shall become the property of the Contractor and will not be paid for. Costs associated with startup operations will not be measured separately for payment but will be included in the payment for Contractor's Quality Control.

(p) **Control Strip Requirements.** After fulfilling the plant startup requirements, one or more control strips shall be constructed on the detour (if available), shoulder (if detour not available) or mainline (if neither detour nor shoulder is available) for the purpose of verifying the required production mix

characteristics and establishing rolling patterns to obtain target requirements. The initial placement of asphalt shall be limited to approximately 500 tons (metric tons) plus or minus 100 tons (metric tons). This material shall then be sampled and tested by the Contractor and the Engineer for VMA, Hveem Stability (when applicable) and all of the characteristics. No additional asphalt shall be placed until all the results are evaluated and necessary adjustments in production and placement procedures are made. No pay adjustments will be made for deviations from target on the approximately 500 tons (metric tons) placement. However no asphalt in this or any subsequent control strips, which is determined to be unacceptable in shall be allowed to remain in the mainline or the shoulder. Such unacceptable asphalt shall be removed and replaced by the contractor at no additional expense to the Department.

After necessary adjustments are made, the above process shall be repeated for the next approximately 500 tons (metric tons) of asphalt placed. Pay adjustments for deviations from target on this second placement will be made at the rate of one half of those specified. If required, additional control strips shall be made until an acceptable product (i.e., within the 1.00 pay factor range) is produced. Pay adjustments for deviations from target on all asphalt after the second placement will be made at the rate specified in Subsection 411.04(n)(9). Control strips will be paid for at the contract unit price (as adjusted) for the appropriate type of asphalt concrete.

Sample Size N=4										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.67	49.33	49.00	48.67	48.33	48.00	47.67	47.33	47.00
0.1	46.67	46.33	46.00	45.67	45.33	45.00	44.67	44.33	44.00	43.67
0.2	43.33	43.00	42.67	42.33	42.00	41.67	41.33	41.00	40.67	40.33
0.3	40.00	39.67	39.33	39.00	38.67	38.33	38.00	37.67	37.33	37.00
0.4	36.67	36.33	36.00	35.67	35.33	35.00	34.67	34.33	34.00	33.67
0.5	33.33	33.00	32.67	32.33	32.00	31.67	31.33	31.00	30.67	30.33
0.6	30.00	29.67	29.33	29.00	28.67	28.33	28.00	27.67	27.33	27.00
0.7	26.67	26.33	26.00	25.67	25.33	25.00	24.67	24.33	24.00	23.67
0.8	23.33	23.00	22.67	22.33	22.00	21.67	21.33	21.00	20.67	20.33
0.9	20.00	19.67	19.33	19.00	18.67	18.33	18.00	17.67	17.33	17.00
1.0	16.67	16.33	16.00	15.67	15.33	15.00	14.67	14.33	14.00	13.67
1.1	13.33	13.00	12.67	12.33	12.00	11.67	11.33	11.00	10.67	10.33
1.2	10.00	9.67	9.33	9.00	8.67	8.33	8.00	7.67	7.33	7.00
1.3	6.67	6.33	6.00	5.67	5.33	5.00	4.67	4.33	4.00	3.67
1.4	3.33	3.00	2.67	2.33	2.00	1.67	1.33	1.00	0.67	0.33
1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=5										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.64	49.29	48.93	48.58	48.22	47.87	47.51	47.15	46.80
0.1	46.44	46.09	45.73	45.38	45.02	44.67	44.31	43.96	43.60	43.25
0.2	42.90	42.54	42.19	41.84	41.48	41.13	40.78	40.43	40.08	39.72
0.3	39.37	39.02	38.67	38.32	37.97	37.62	37.28	36.93	36.58	36.23
0.4	35.88	35.54	35.19	34.85	34.50	34.16	33.81	33.47	33.12	32.78
0.5	32.44	32.10	31.76	31.42	31.08	30.74	30.40	30.06	29.73	29.39
0.6	29.05	28.72	28.39	28.05	27.72	27.39	27.06	26.73	26.40	26.07
0.7	25.74	25.41	25.09	24.76	24.44	24.11	23.79	23.47	23.15	22.83
0.8	22.51	22.19	21.87	21.56	21.24	20.93	20.62	20.31	20.00	19.69
0.9	19.38	19.07	18.77	18.46	18.16	17.86	17.55	17.25	16.96	16.66
1.0	16.36	16.07	15.78	15.48	15.19	14.91	14.62	14.33	14.05	13.76
1.1	13.48	13.20	12.93	12.65	12.37	12.10	11.83	11.56	11.29	11.02
1.2	10.76	10.50	10.23	9.97	9.72	9.46	9.21	8.96	8.71	8.46
1.3	8.21	7.97	7.73	7.49	7.25	7.02	6.79	6.56	6.33	6.10
1.4	5.88	5.66	5.44	5.23	5.02	4.81	4.60	4.39	4.19	3.99
1.5	3.80	3.61	3.42	3.23	3.05	2.87	2.69	2.52	2.35	2.19
1.6	2.03	1.87	1.72	1.57	1.42	1.28	1.15	1.02	0.89	0.77
1.7	0.66	0.55	0.45	0.36	0.27	0.19	0.12	0.06	0.02	0.00
1.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=6										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.63	49.27	48.90	48.53	48.16	47.80	47.43	47.06	46.70
0.1	46.33	45.96	45.60	45.23	44.86	44.50	44.13	43.77	43.40	43.04
0.2	42.68	42.31	41.95	41.59	41.22	40.86	40.50	40.14	39.78	39.42
0.3	39.06	38.70	38.34	37.98	37.62	37.27	36.91	36.55	36.20	35.84
0.4	35.49	35.14	34.79	34.43	34.08	33.73	33.38	33.04	32.69	32.34
0.5	32.00	31.65	31.31	30.96	30.62	30.28	29.94	29.60	29.26	28.93
0.6	28.59	28.25	27.92	27.59	27.26	26.92	26.60	26.27	25.94	25.61
0.7	25.29	24.96	24.64	24.32	24.00	23.68	23.37	23.05	22.74	22.42
0.8	22.11	21.80	21.49	21.18	20.88	20.57	20.27	19.97	19.67	19.37
0.9	19.07	18.78	18.49	18.19	17.90	17.61	17.33	17.04	16.76	16.48
1.0	16.20	15.92	15.64	15.37	15.09	14.82	14.55	14.29	14.02	13.76
1.1	13.50	13.24	12.98	12.72	12.47	12.22	11.97	11.72	11.47	11.23
1.2	10.99	10.75	10.51	10.28	10.04	9.81	9.58	9.36	9.13	8.91
1.3	8.69	8.48	8.26	8.05	7.84	7.63	7.42	7.22	7.02	6.82
1.4	6.63	6.43	6.24	6.05	5.87	5.68	5.50	5.33	5.15	4.98
1.5	4.81	4.64	4.47	4.31	4.15	4.00	3.84	3.69	3.54	3.40
1.6	3.25	3.11	2.97	2.84	2.71	2.58	2.45	2.33	2.21	2.09
1.7	1.98	1.87	1.76	1.66	1.55	1.45	1.36	1.27	1.18	1.09
1.8	1.01	0.93	0.85	0.78	0.71	0.64	0.57	0.51	0.46	0.40
1.9	0.35	0.30	0.26	0.22	0.18	0.15	0.12	0.09	0.07	0.05
2.0	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=7										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.63	49.25	48.88	48.50	48.13	47.76	47.38	47.01	46.63
0.1	46.26	45.89	45.51	45.14	44.77	44.40	44.03	43.65	43.28	42.91
0.2	42.54	42.17	41.80	41.44	41.07	40.70	40.33	39.97	39.60	39.23
0.3	38.87	38.50	38.14	37.78	37.42	37.06	36.69	36.33	35.98	35.62
0.4	35.26	34.90	34.55	34.19	33.84	33.49	33.13	32.78	32.43	32.08
0.5	31.74	31.39	31.04	30.70	30.36	30.01	29.67	29.33	28.99	28.66
0.6	28.32	27.98	27.65	27.32	26.99	26.66	26.33	26.00	25.68	25.35
0.7	25.03	24.71	24.39	24.07	23.75	23.44	23.12	22.81	22.50	22.19
0.8	21.88	21.58	21.27	20.97	20.67	20.37	20.07	19.78	19.48	19.19
0.9	18.90	18.61	18.33	18.04	17.76	17.48	17.20	16.92	16.65	16.37
1.0	16.10	15.83	15.56	15.30	15.03	14.77	14.51	14.26	14.00	13.75
1.1	13.49	13.25	13.00	12.75	12.51	12.27	12.03	11.79	11.56	11.33
1.2	11.10	10.87	10.65	10.42	10.20	9.98	9.77	9.55	9.34	9.13
1.3	8.93	8.72	8.52	8.32	8.12	7.92	7.73	7.54	7.35	7.17
1.4	6.98	6.80	6.62	6.45	6.27	6.10	5.93	5.77	5.60	5.44
1.5	5.28	5.13	4.97	4.82	4.67	4.52	4.38	4.24	4.10	3.96
1.6	3.83	3.69	3.57	3.44	3.31	3.19	3.07	2.95	2.84	2.73
1.7	2.62	2.51	2.41	2.30	2.20	2.11	2.01	1.92	1.83	1.74
1.8	1.65	1.57	1.49	1.41	1.34	1.26	1.19	1.12	1.06	0.99
1.9	0.93	0.87	0.81	0.76	0.70	0.65	0.60	0.56	0.51	0.47
2.0	0.43	0.39	0.36	0.32	0.29	0.26	0.23	0.21	0.18	0.16
2.1	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.02
2.2	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=8										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.62	49.24	48.86	48.49	48.11	47.73	47.35	46.97	46.59
0.1	46.22	45.84	45.46	45.08	44.71	44.33	43.96	43.58	43.21	42.83
0.2	42.46	42.08	41.71	41.34	40.97	40.59	40.22	39.85	39.48	39.11
0.3	38.75	38.38	38.01	37.65	37.28	36.92	36.55	36.19	35.83	35.47
0.4	35.11	34.75	34.39	34.04	33.68	33.33	32.97	32.62	32.27	31.92
0.5	31.57	31.22	30.87	30.53	30.18	29.84	29.50	29.16	28.82	28.48
0.6	28.15	27.81	27.48	27.15	26.82	26.49	26.16	25.83	25.51	25.19
0.7	24.86	24.54	24.23	23.91	23.59	23.28	22.97	22.66	22.35	22.04
0.8	21.74	21.44	21.14	20.84	20.54	20.24	19.95	19.66	19.37	19.08
0.9	18.79	18.51	18.23	17.95	17.67	17.39	17.12	16.85	16.57	16.31
1.0	16.04	15.78	15.51	15.25	15.00	14.74	14.49	14.24	13.99	13.74
1.1	13.49	13.25	13.01	12.77	12.54	12.30	12.07	11.84	11.61	11.39
1.2	11.17	10.94	10.73	10.51	10.30	10.09	9.88	9.67	9.47	9.26
1.3	9.06	8.87	8.67	8.48	8.29	8.10	7.91	7.73	7.55	7.37
1.4	7.19	7.02	6.85	6.68	6.51	6.35	6.19	6.03	5.87	5.71
1.5	5.56	5.41	5.26	5.12	4.97	4.83	4.69	4.56	4.42	4.29
1.6	4.16	4.03	3.91	3.79	3.67	3.55	3.43	3.32	3.21	3.10
1.7	2.99	2.89	2.79	2.69	2.59	2.49	2.40	2.31	2.22	2.13
1.8	2.04	1.96	1.88	1.80	1.72	1.65	1.58	1.51	1.44	1.37
1.9	1.31	1.24	1.18	1.12	1.07	1.01	0.96	0.91	0.86	0.81
2.0	0.76	0.72	0.67	0.63	0.59	0.55	0.52	0.48	0.45	0.42
2.1	0.39	0.36	0.33	0.30	0.28	0.26	0.23	0.21	0.19	0.17
2.2	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05
2.3	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00
2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=9										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.62	49.24	48.85	48.47	48.09	47.71	47.33	46.95	46.57
0.1	46.18	45.80	45.42	45.04	44.66	44.29	43.91	43.53	43.15	42.77
0.2	42.40	42.02	41.64	41.27	40.89	40.52	40.15	39.77	39.40	39.03
0.3	38.66	38.29	37.92	37.55	37.19	36.82	36.46	36.09	35.73	35.37
0.4	35.00	34.64	34.29	33.93	33.57	33.21	32.86	32.51	32.15	31.80
0.5	31.45	31.10	30.76	30.41	30.07	29.72	29.38	29.04	28.70	28.36
0.6	28.03	27.69	27.36	27.03	26.70	26.37	26.04	25.72	25.39	25.07
0.7	24.75	24.43	24.11	23.80	23.49	23.17	22.86	22.56	22.25	21.94
0.8	21.64	21.34	21.04	20.75	20.45	20.16	19.87	19.58	19.29	19.00
0.9	18.72	18.44	18.16	17.88	17.61	17.33	17.06	16.79	16.53	16.26
1.0	16.00	15.74	15.48	15.23	14.97	14.72	14.47	14.22	13.98	13.73
1.1	13.49	13.26	13.02	12.79	12.55	12.32	12.10	11.87	11.65	11.43
1.2	11.21	11.00	10.78	10.57	10.36	10.15	9.95	9.75	9.55	9.35
1.3	9.16	8.96	8.77	8.59	8.40	8.22	8.04	7.86	7.68	7.51
1.4	7.33	7.17	7.00	6.83	6.67	6.51	6.35	6.20	6.04	5.89
1.5	5.74	5.60	5.45	5.31	5.17	5.03	4.90	4.77	4.64	4.51
1.6	4.38	4.26	4.14	4.02	3.90	3.78	3.67	3.56	3.45	3.34
1.7	3.24	3.14	3.03	2.94	2.84	2.75	2.65	2.56	2.47	2.39
1.8	2.30	2.22	2.14	2.06	1.98	1.91	1.84	1.76	1.70	1.63
1.9	1.56	1.50	1.44	1.37	1.32	1.26	1.20	1.15	1.10	1.05
2.0	1.00	0.95	0.90	0.86	0.82	0.77	0.73	0.70	0.66	0.62
2.1	0.59	0.55	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33
2.2	0.31	0.29	0.27	0.25	0.23	0.21	0.20	0.18	0.17	0.15
2.3	0.14	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.05
2.4	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.5	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=10										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.62	49.23	48.85	48.46	48.08	47.70	47.31	46.93	46.54
0.1	46.16	45.78	45.40	45.01	44.63	44.25	43.87	43.49	43.11	42.73
0.2	42.35	41.97	41.60	41.22	40.84	40.47	40.09	39.72	39.34	38.97
0.3	38.60	38.23	37.86	37.49	37.12	36.75	36.38	36.02	35.65	35.29
0.4	34.93	34.57	34.21	33.85	33.49	33.13	32.78	32.42	32.07	31.72
0.5	31.37	31.02	30.67	30.32	29.98	29.64	29.29	28.95	28.61	28.28
0.6	27.94	27.60	27.27	26.94	26.61	26.28	25.96	25.63	25.31	24.99
0.7	24.67	24.35	24.03	23.72	23.41	23.10	22.79	22.48	22.18	21.87
0.8	21.57	21.27	20.98	20.68	20.39	20.10	19.81	19.52	19.23	18.95
0.9	18.67	18.39	18.11	17.84	17.56	17.29	17.03	16.76	16.49	16.23
1.0	15.97	15.72	15.46	15.21	14.96	14.71	14.46	14.22	13.97	13.73
1.1	13.50	13.26	13.03	12.80	12.57	12.34	12.12	11.90	11.68	11.46
1.2	11.24	11.03	10.82	10.61	10.41	10.21	10.00	9.81	9.61	9.42
1.3	9.22	9.03	8.85	8.66	8.48	8.30	8.12	7.95	7.77	7.60
1.4	7.44	7.27	7.10	6.94	6.78	6.63	6.47	6.32	6.17	6.02
1.5	5.87	5.73	5.59	5.45	5.31	5.18	5.05	4.92	4.79	4.66
1.6	4.54	4.41	4.30	4.18	4.06	3.95	3.84	3.73	3.62	3.52
1.7	3.41	3.31	3.21	3.11	3.02	2.93	2.83	2.74	2.66	2.57
1.8	2.49	2.40	2.32	2.25	2.17	2.09	2.02	1.95	1.88	1.81
1.9	1.75	1.68	1.62	1.56	1.50	1.44	1.38	1.33	1.27	1.22
2.0	1.17	1.12	1.07	1.03	0.98	0.94	0.90	0.86	0.82	0.78
2.1	0.74	0.71	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46
2.2	0.44	0.41	0.39	0.37	0.34	0.32	0.30	0.29	0.27	0.25
2.3	0.23	0.22	0.20	0.19	0.18	0.16	0.15	0.14	0.13	0.12
2.4	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05
2.5	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=10										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.62	49.23	48.85	48.46	48.08	47.70	47.31	46.93	46.54
0.1	46.16	45.78	45.40	45.01	44.63	44.25	43.87	43.49	43.11	42.73
0.2	42.35	41.97	41.60	41.22	40.84	40.47	40.09	39.72	39.34	38.97
0.3	38.60	38.23	37.86	37.49	37.12	36.75	36.38	36.02	35.65	35.29
0.4	34.93	34.57	34.21	33.85	33.49	33.13	32.78	32.42	32.07	31.72
0.5	31.37	31.02	30.67	30.32	29.98	29.64	29.29	28.95	28.61	28.28
0.6	27.94	27.60	27.27	26.94	26.61	26.28	25.96	25.63	25.31	24.99
0.7	24.67	24.35	24.03	23.72	23.41	23.10	22.79	22.48	22.18	21.87
0.8	21.57	21.27	20.98	20.68	20.39	20.10	19.81	19.52	19.23	18.95
0.9	18.67	18.39	18.11	17.84	17.56	17.29	17.03	16.76	16.49	16.23
1.0	15.97	15.72	15.46	15.21	14.96	14.71	14.46	14.22	13.97	13.73
1.1	13.50	13.26	13.03	12.80	12.57	12.34	12.12	11.90	11.68	11.46
1.2	11.24	11.03	10.82	10.61	10.41	10.21	10.00	9.81	9.61	9.42
1.3	9.22	9.03	8.85	8.66	8.48	8.30	8.12	7.95	7.77	7.60
1.4	7.44	7.27	7.10	6.94	6.78	6.63	6.47	6.32	6.17	6.02
1.5	5.87	5.73	5.59	5.45	5.31	5.18	5.05	4.92	4.79	4.66
1.6	4.54	4.41	4.30	4.18	4.06	3.95	3.84	3.73	3.62	3.52
1.7	3.41	3.31	3.21	3.11	3.02	2.93	2.83	2.74	2.66	2.57
1.8	2.49	2.40	2.32	2.25	2.17	2.09	2.02	1.95	1.88	1.81
1.9	1.75	1.68	1.62	1.56	1.50	1.44	1.38	1.33	1.27	1.22
2.0	1.17	1.12	1.07	1.03	0.98	0.94	0.90	0.86	0.82	0.78
2.1	0.74	0.71	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46
2.2	0.44	0.41	0.39	0.37	0.34	0.32	0.30	0.29	0.27	0.25
2.3	0.23	0.22	0.20	0.19	0.18	0.16	0.15	0.14	0.13	0.12
2.4	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05
2.5	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample Size N=30										
Q	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	50.00	49.60	49.21	48.81	48.42	48.02	47.63	47.24	46.84	46.45
0.1	46.05	45.66	45.27	44.88	44.48	44.09	43.70	43.31	42.92	42.53
0.2	42.15	41.76	41.37	40.99	40.60	40.22	39.83	39.45	39.07	38.69
0.3	38.31	37.93	37.55	37.18	36.80	36.43	36.05	35.68	35.31	34.94
0.4	34.58	34.21	33.85	33.48	33.12	32.76	32.40	32.04	31.69	31.33
0.5	30.98	30.63	30.28	29.93	29.59	29.24	28.90	28.56	28.22	27.89
0.6	27.55	27.22	26.89	26.56	26.23	25.90	25.58	25.26	24.94	24.62
0.7	24.31	23.99	23.68	23.37	23.07	22.76	22.46	22.16	21.86	21.57
0.8	21.27	20.98	20.69	20.40	20.12	19.84	19.56	19.28	19.00	18.73
0.9	18.46	18.19	17.92	17.66	17.40	17.14	16.88	16.63	16.37	16.12
1.0	15.88	15.63	15.39	15.15	14.91	14.67	14.44	14.21	13.98	13.75
1.1	13.53	13.31	13.09	12.87	12.66	12.45	12.24	12.03	11.82	11.62
1.2	11.42	11.22	11.03	10.84	10.64	10.46	10.27	10.09	9.90	9.72
1.3	9.55	9.37	9.20	9.03	8.86	8.69	8.53	8.37	8.21	8.05
1.4	7.90	7.74	7.59	7.44	7.30	7.15	7.01	6.87	6.73	6.60
1.5	6.46	6.33	6.20	6.07	5.95	5.82	5.70	5.58	5.46	5.34
1.6	5.23	5.12	5.01	4.90	4.79	4.68	4.58	4.48	4.38	4.28
1.7	4.18	4.09	3.99	3.90	3.81	3.72	3.63	3.55	3.47	3.38
1.8	3.30	3.22	3.15	3.07	2.99	2.92	2.85	2.78	2.71	2.64
1.9	2.57	2.51	2.45	2.38	2.32	2.26	2.20	2.14	2.09	2.03
2.0	1.98	1.93	1.87	1.82	1.77	1.73	1.68	1.63	1.59	1.54
2.1	1.50	1.46	1.42	1.38	1.34	1.30	1.26	1.22	1.19	1.15
2.2	1.12	1.09	1.05	1.02	0.99	0.96	0.93	0.90	0.88	0.85
2.3	0.82	0.80	0.77	0.75	0.72	0.70	0.68	0.66	0.63	0.61
2.4	0.59	0.57	0.56	0.54	0.52	0.50	0.48	0.47	0.45	0.44
2.5	0.42	0.41	0.39	0.38	0.37	0.35	0.34	0.33	0.32	0.30
2.6	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.22	0.21
2.7	0.20	0.19	0.18	0.18	0.17	0.16	0.16	0.15	0.14	0.14
2.8	0.13	0.13	0.12	0.12	0.11	0.11	0.10	0.10	0.09	0.09
2.9	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06
3.0	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04
3.1	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
3.2	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
3.3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3.4	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Use of Contractor's Test Results for Acceptance Purposes

Part 1: Guidelines for Initial Validation of Contractor's Test Methods

In order to utilize the Contractor's material test results for acceptance and payment, the Department must ensure that the Contractor's results compare favorably with the Department's test results for the same material and same quality characteristic. The following procedure can be used to determine the initial validity of the Contractor's test methods:

1. A "paired test" (as referred to herein) will be any time two (2) separate tests are conducted by the Department and the Contractor (one test each) where the material tested has been collected as a true split sample or was sampled at the same time, from the same lot, sublot and batch, and from the same proximity within the batch. For asphalt air voids, asphalt cement content, and gradation testing, "paired" tests are those tests performed on split samples or samples taken from the same batch and from the same proximity within the batch. For roadway density and thickness measurements from cores, "paired" tests are those measurements performed on the exact same cores. For concrete unit weight, slump, and air content, "paired" tests are those conducted on samples taken from the same batch and from the same proximity within the batch. For concrete, the compressive strength "paired" test will generally be the average strength of two or three specimens each (by the Department and the Contractor). The specimens are cast from concrete sampled from the same batch and from the same proximity within the batch.

2. For each quality characteristic for which the Contractor's test methods are to be validated, the Department will conduct a minimum of ten (10) initial paired tests with the Contractor.

3. The Engineer may, at his discretion, exclude from this and subsequent analyses any paired test data that clearly exhibit explainable special-cause variation provided the cause of said variation has been identified and corrected so as to be unlikely to reoccur.

4. For each quality characteristic, calculate the paired-t test statistic (t_p), the average of the paired differences ($\overline{X}_p$) and the standard deviation of the paired differences (S_p) as follows:

$$t_p = \left| \sqrt{N_p} \frac{\overline{X}_p}{S_p} \right| \qquad \overline{X}_P = \frac{\sum_{i=1}^{N_P} \left(C_i - D_i \right)}{N_P} \qquad S_P = \sqrt{\frac{\sum_{i=1}^{N_P} \left(C_i - D_i - \overline{X}_P \right)^2}{N_{P-1}}}$$

Equation (1) Equation (2) Equation (3)

Where:

t_p = Paired-t test statistic. This value will be compared to a critical t-value (t_{crit}) to be obtained from Table 1.

N_p = The number of paired tests conducted. Each "paired test" consists of two individual tests (one by the Contractor and one by the Department) performed on a single split sample.

$\overline{X_p}$ = The average of the differences between the paired tests. This should not be confused with the difference between the averages. The correct order for computing $\overline{X_p}$ is to calculate all the differences between the paired tests, then take the average of those differences.

S_p= The standard deviation of the differences between the paired tests. As with $\overline{X_p}$, the correct order for computing S_p is to calculate all the differences between the paired tests, then take the standard deviation of those differences.

C_i = The Contractor's individual test result for a given split sample *i*.

D_i = The Department's individual test result for a given split sample *i*.

N_{p-1} = The number of degrees of freedom for use with Table 1.

5. Obtain the critical t-value t_{crit}, from Table 1, using N_{p-1} as the number of degrees of freedom.

6. Compare the calculated paired-t statistic (t_p) to the corresponding critical value from Table 1 (t_{crit}).

7. If t_p is less than t_{crit}, the Contractor's test methods for that quality characteristic are without significant bias. The Contractor's test methods for that quality characteristic can be considered valid at the present time. Proceed to Step 12.

8. If t_p is greater than or equal to t_{crit}, there exists a *statistically*-significant bias (= $\overline{X_p}$) between the Contractor's and the Department's test methods.

9. Compare the Contractor's testing bias ($\overline{X_p}$) to the relevant Allowable Testing Bias (ATB) from the following table:

PCC Quality	Allowable Testing Bias (ATB)	Units
Gradation:		
Sieve # 200 (Coarse)	± 0.40	%-passing
Sieve # 200 (Fine)	± 0.30	%-passing
Unit Weight	± 0.80	pcf
Slump	± 0.30	inch
Air Content	± 0.30	% (by volume)
Compressive Strength	± 100	psi

AC Quality Characteristic	Allowable Testing Bias (ATB)	Units
Gradation:		
Sieves #4 and larger	± 1.50	%-passing
Sieves #10 through #80	± 1.00	%-passing
Sieve # 200	± 0.50	%-passing
Asphalt Cement Content	± 0.15	% (by weight)
Air Voids (LMS)	± 0.50	% (by volume)
Roadway Density	± 0.50	% max. theor.

10. If the magnitude of $\overline{X_p}$ is less than the magnitude of the corresponding ATB, the Contractor's bias for that quality characteristic, though *statistically*-significant, is not practically

significant. The Contractor's test methods for that quality characteristic can be considered valid at the present time. Proceed to Step 12.

11. If the magnitude of $\overline{X}_p$ is greater than or equal to the magnitude of the corresponding ATB, the Contractor's bias for that quality characteristic is practically significant and unacceptable. The Contractor's test results for that quality characteristic will not be used for acceptance unless and until the Contractor's test methods are validated as follows:
    (1) The respective test equipment used during the paired testing (both the Contractor's and the Department's) shall be inspected and tested for calibration by a qualified independent calibration specialist.
    (2) A calibration test certificate shall be prepared by the calibration specialist identifying the pre-calibration errors at various measurement levels such that the paired test data are fully bracketed by the pre-calibration error estimates.
    (3) The paired test results will then be adjusted by the Engineer so as to effectively nullify the errors identified on each calibration test certificate.
    (4) Return to Step 4, using the adjusted paired test data in lieu of the original paired test data.

12. Once the Contractor's test methods for a given quality characteristic have been validated, the Engineer will provide ongoing validation of the Contractor's test method in accordance with the *Guidelines for Ongoing Validation of Contractor's Test Methods.*

Table 1 – Critical Values for the Paired-t Test Statistic (based on $\alpha = 0.01$)

Degrees of Freedom (N_p - 1)	Critical t-value (t_{crit})	Degrees of Freedom (N_p - 1)	Critical t-value (t_{crit})	Degrees of Freedom (N_p - 1)	Critical t-value (t_{crit})
2	9.925	25	2.787	48	2.682
3	5.841	26	2.779	49	2.680
4	4.604	27	2.771	50	2.678
5	4.032	28	2.763	60	2.660
6	3.707	29	2.756	70	2.648
7	3.499	30	2.750	80	2.639
8	3.355	31	2.744	90	2.632
9	3.250	32	2.738	100	2.626
10	3.169	33	2.733	110	2.621
11	3.106	34	2.728	120	2.617
12	3.055	35	2.724	130	2.614
13	3.012	36	2.719	140	2.611
14	2.977	37	2.715	150	2.609
15	2.947	38	2.712	160	2.607
16	2.921	39	2.708	170	2.605
17	2.898	40	2.704	180	2.603
18	2.878	41	2.701	190	2.602
19	2.861	42	2.698	200	2.601
20	2.845	43	2.695	300	2.592
21	2.831	44	2.692	400	2.588
22	2.819	45	2.690	500	2.586
23	2.807	46	2.687	1000	2.581
24	2.797	47	2.685	10000	2.576

Use of Contractor's Test Results for Acceptance Purposes

Part 2: Guidelines for Ongoing Validation of Contractor's Test Methods

After the Department has initially validated the Contractor's test method for a particular quality characteristic as outlined in the Guidelines for Initial Validation of Contractor's Test Methods, the following procedure will be used for ongoing validation of the Contractor's test methods for that quality characteristic. The ongoing validation will be performed by the Engineer through the creation and maintenance of a "testing-bias" control chart for that quality characteristic. The purpose of the control chart will be to document the bias (over time) between the Contractor's and the Department's testing procedures and to identify any changes that occur with the Contractor's (or Department's) test methods during the prosecution of the project. The following procedures are meant to guide the Engineer in the use of testing-bias control charts:

1. The values to be reported on the testing-bias control chart will be the differences (for that quality characteristic) between the Contractor's and the Department's test results for all paired tests conducted for that quality characteristic for the project. In general, "paired" tests are those tests performed on materials sampled at the same time, from the same batch and from the same proximity within the batch. The differences will be recorded and charted as $Ci - Di$, where Ci = the Contractor's individual test result for a given split sample i, and Di = the Department's individual test result for that same split sample.

2. In addition to the initial paired tests (performed during the initial validation of the Contractor's test methods), the Engineer will periodically conduct additional ongoing paired tests with the Contractor. The frequency of ongoing paired testing will, in general, be one (1) paired test per lot, but should not be less than one (1) paired test for every ten (10) sublots.

3. The control charts will be maintained and kept current and will follow the same guidelines and requirements as those specified for the *Contractor's control charts in the Control Charts for Quality Control.*

4. In the event an out-of-control condition is observed for testing bias,
   a) The Contractor and Engineer shall immediately investigate the probable cause.
   b) If the probable cause is identified and corrected or if the resulting bias is (according to the judgment of the Engineer) not likely to exceed the limits for Allowable Testing Bias (ATB) set forth in the *Guidelines for Initial Validation of Contractor's Test Methods,*
      i) Acceptance and pay adjustments for that quality characteristic will continue to be based on the Contractor's test results.
      ii) At the Engineer's discretion, the errant test results may be discarded from the acceptance and pay-adjustment calculations. If replacement test results are available (i.e. Department tests were performed on the same sublots as the discarded Contractor test results) the Department's test results may, at the Engineer's discretion, be substituted for the discarded test results.
   c) If the probable cause is not corrected and the resulting bias is (according to the judgment of the Engineer) likely to exceed the limits for Allowable Testing Bias (ATB) set forth in the Guidelines for Initial Validation of Contractor's Test Methods,
      i) All subsequent testing for that quality characteristic will be paired testing until such time as the source of the unacceptable testing bias is clearly identified and corrected and the validity of the Contractor's test methods has been re-established.

ii) During this period of 100% paired testing, acceptance and pay adjustments for that quality characteristic will be based on the Department's test results rather than the Contractor's.