KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION OF 1990

NOTE: This special provision is generally written in the imperative mood. The subject, "the *Contractor*" is implied. Also implied in this language are "*shall*", "*shall be*", or similar words and phrases. The word "*will*" generally pertains to decisions or actions of the Kansas Department of Transportation.

Add a new Section to Division 500:

DIVISION 500

PORTLAND CEMENT CONCRETE PAVEMENT
(Quality Control/Quality Assurance (QC/QA))

1.0 DESCRIPTION

Construct a concrete pavement on a prepared subgrade or base course. Demonstrate quality control by providing quality control testing.

BID ITEM	UNIT
Concrete Pavement (* Uniform) (AE) (**)	Square Yard (square meter)
Quality Control Testing (PCCP)	Square Yard (square meter)

* Thickness
** No entry denotes PCCP with mesh and dowel assemblies. "Plain" denotes PCCP without mesh and dowel assemblies. "NRDJ" denotes non-reinforced dowel jointed PCCP.

2.0 CONTRACTOR QUALITY CONTROL REQUIREMENTS

a. General. Provide qualified personnel and sufficient equipment complying with the requirements listed in the Department's Construction Manual to conduct quality control testing and complies with the Sampling and Testing Frequency Chart for Portland Cement Concrete Pavement for Quality Control/Quality Assurance Projects in Appendix B of the Department's Construction Manual.

Calibrate and correlate the testing equipment with prescribed procedures and conduct tests in conformance with specified testing procedures as listed in the Department's Construction Manual.

Maintain control charts on an ongoing basis.

File all reports, records, and diaries developed during the progress of construction activities as directed by the Engineer. Files become the property of the Engineer.

Provide the following test data:

- Make copies of all test results and control charts readily available to the Engineer at the project site.

- Copies of all failing test results (based on a moving average of four tests, when appropriate) and summary sheet sent by facsimile on a daily basis to the Construction Engineer.

b. Quality Control Organization. Submit a listing of the names and phone numbers of individuals and alternates responsible for quality control administration and inspection along with the proposed mix design data. Provide an organizational chart that shows the specified lines of authority relating both to mix design and quality control operations during production. Post a copy of the organizational chart in the Contractor's test facility.

The Contractor's quality control organization or private testing firms must have personnel who are certified in accordance with the requirements of the Policy and Procedures Manual for The Certified Inspection and Testing (CIT^2) Training Program. Only persons certified in the appropriate classifications covering the specific tests required may perform such testing. This project will require testing be performed by contractor representatives certified in the AGF, PO, NUC, CF and CS classifications. Contractors are required to have at least one employee on the project certified in the "QC/QA Con Spec" classification.

c. Certified Technicians Required Duties. Be available on the project site whenever concrete is being produced for use on or being placed on the project site. Perform and utilize quality control tests and other quality control practices to assure that delivered materials and proportioning meet the requirements of the mix designs, including temperature, slump, air content, and strength.

Periodically inspect all equipment utilized in transporting, proportioning, mixing, placing, consolidating, finishing, and curing so that it is operating properly and that placement, consolidation, finishing, and curing comply with the mix design and other Contract requirements.

d. Testing Facilities. Locate the Contractor's testing facility at the plant site or at the project site. Obtain approval of the facility by the Engineer before the commencement of mixture production. Any other laboratory location requires approval by the District Materials Engineer. Provide suitable space and specified testing equipment for use by the Contractor's quality control personnel to perform tests as required.

KDOT's Materials and Research Center is Accredited through the AASHTO Accreditation Program (AAP). If the contractor's QC laboratory is not participating in the AAP, then the contractor shall have an AAP approved laboratory inspect the QC laboratory's equipment annually. The inspection shall include all equipment necessary to perform testing on specified types of material related to this contract; base and grading, aggregate, bituminous and concrete.

Maintain a Quality Manual in the field laboratory showing all calibrations performed on all test equipment and when the next calibration is due for that equipment. As a minimum, follow the calibration/verification interval established in Construction Manual, Part V, Section 5.17.10.02, Table 1: Concrete Materials Test Equipment. Appendix A of that section also provides an example of a laboratory quality manual.

To facilitate communication between the Contractor and the Engineer regarding quality control, equip the Contractor's testing facility with these items:

- A telephone with a private line for the exclusive use of the testing facility's quality control personnel.
- A copying machine.
- A facsimile machine for use by contractor personnel and the Engineer.

e. Testing Requirements. Take all samples for tests at random locations, selected as specified in the Contractors quality control plan and at the rates specified in the Sampling and Testing Frequency Chart for Portland Cement Concrete Pavement for Quality Control/Quality Assurance Projects in Appendix B of Part V of the Department's Construction Manual. Retain the latest 10 gradation samples for use by the Engineer in case of a dispute, or other circumstances requiring re-testing.

f. Documentation. Maintain adequate records of all inspections and tests. Indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and the nature of corrective action taken as appropriate in the records. The Contractor's documentation procedures will be subject to approval by the Engineer before the start of the work and to compliance checks during the progress of the work. (Include in the QC Plan.)

(1) Record and document all test results and calculations on data sheets that are acceptable to the Engineer. Record specific test results on a daily summary sheet approved by the Engineer to facilitate the computation of moving test averages. Base moving averages on 4 consecutive test results. Include a description of quality control actions taken (adjustment of aggregate or additive proportions in the mix, moisture adjustments, etc.) in the Daily Quality Control Summary Sheet.

(2) Post and keep current all quality control charts; show both individual test results and moving average values. As a minimum, plot the single test values and the 4 test moving average values on approved control charts for the following properties:

- Percent air in concrete mixture.
- Slump of concrete mixture.
- Concrete unit weight(mass).
- In place concrete density on plastic concrete as a percentage of determined unit weight(mass).
- Gradation of individual aggregates.

(3) Plot individual test results in black for each test point. Connect points with a solid black line. Plot the moving average for each test variable in red starting with the fourth test. Connect the points with a dashed red line. Plot the Department's verification test results with green asterisks. Do not include the Department's verification tests in the moving average.

Indicate specification working range limits for single test results on the control charts using a green inked dotted line and for 4 test moving average results with a green inked solid line.

(4) Charts and Forms. Keep all conforming and non-conforming inspections and test results complete and available at all times to the Engineer during the performance of the work.

Provide forms on a computer-acceptable medium where required. Document batch tickets and gradation data in accordance with Department requirements.

The Contractor may use other types of control charts as deemed appropriate. It is normally expected that testing and charting will be completed within 24 hours after sampling.

All charts and records documenting the Contractor's quality control inspections and tests become property of the Department upon completion of the work.

g. Corrective Action. Notify the Engineer when the moving average test result trend line for any property approaches the specification limits. Cease operations if 2 consecutive moving average points fall outside the specification limits. Ceasing operations is the Contractor's responsibility. Quality control tests for this determination includes aggregate gradation, compliance with the mix design band, entrained air content, concrete unit weight(mass), and density of fresh concrete in place. Production will be suspended pending the satisfactory results of a pre-production sample, unless waived by the District Materials Engineer.

Failure to cease operations for the conditions cited above will subject all subsequent material to rejection by the Engineer, or acceptance at a reduced price, as determined by the Engineer.

The Engineer may examine materials represented by individual test results, which lie beyond the Contractor's normal quality control testing variation. The investigation may be based on either Contractor's test results or the Department's test results. The information from additional testing (including testing of in place pavement) may be used to define unacceptable materials according to **subsection 106.08**, and apply appropriate price reductions or initiate corrective action as determined by the Engineer.

For any test not pertaining to compressive strengths or thickness determination, if a dispute exists between the Engineer and the Contractor about the validity of the others test results, the KDOT District Materials Laboratory or Materials and Research Center (MRC) will perform referee testing. If one of the disputed Department test result was generated at the MRC, then an Independent Laboratory agreeable to both parties will be selected. The AASHTO Accreditation Program must have approved the selected laboratory for the appropriate test procedure. If referee testing indicates that the Department's test results are correct, then the Contractor pays for the additional testing, including referee testing performed at the MRC. If the referee testing indicates that the Contractor's test results are correct then the Department pays for the additional testing.

Follow the procedures outlined in **subsection 4.0** of this Special Provision if a dispute arises for any test determining compressive strengths or thickness.

h. Non-Conforming Materials. Establish and maintain an effective and positive system for controlling non-conforming material, including procedures for its identification, isolation and disposition. Reclaim or rework non-conforming materials in accordance with procedures acceptable to the Engineer.

Positively identify all non-conforming materials and products to prevent use, shipment, and intermingling with conforming materials and products. Provide holding areas, mutually agreeable to the Engineer and the Contractor.

i. Quality Control Plan. Prepare a Quality Control Plan that addresses all requirements detailed in **subsection 2.0** of this Special Provision, and submit it to the Engineer in writing not less than 2 weeks before work begins. A suggested outline that may be adapted to the Contractor's organization and operation is as follows:

(1) Identify personnel responsible for Contractor QC.

- Company official as liaison with Department.
- Certified Technician who will direct inspection and testing.

(2) Include the organizational chart.

(3) Include Certified Technician required duties as defined in the specification.

(4) Describe the testing facility and its accreditation, and where it will be located on this project.

(5) Identify test methods, procedures, and equipment proposed for use. It is intended that the Contractor use standard Department test methods, and that measuring and testing equipment be standard and properly calibrated as outlined in Part V, Construction Manual. Detail any alternative sampling method, procedure or inspection equipment proposed to be used. Such alternatives are subject to review and approval by the District Materials Engineer.

(6) Include procedures, charts and forms to be used to provide documentation required in the specification.

(7) Identify procedures for notifying the Engineer when corrective measures must be implemented, and for halting production if necessary.

(8) Specifically address how non-conforming materials will be controlled and identified.

(9) List the grades of concrete involved in the project separately. For each grade of concrete to be used, include, but don't necessarily limit to the following:

- Mix designs. List mix design numbers if using existing mixes.
- Aggregate production.
- Quality of components.
- Stockpile management.
- Proportioning, including added water.
- Mixing and transportation.
- Initial mix properties.
- Placement and consolidation.
- Concrete yield.
- Compressive strength.
- Finishing and curing.
- Frequency of sampling and testing.
- How duties and responsibilities are to be accomplished and documented, and if more than one Certified Technician is required.
- The criteria used by the Technician to correct or reject unsatisfactory materials.

3.0 MATERIALS.

Provide materials that comply with the requirements of **subsection 502.02** (including all applicable Special Provisions, such as 90M/P-156, latest revision and 90M/P-266, latest revision).

4.0 CONSTRUCTION REQUIREMENTS.

The construction requirements will comply with the requirements of subsection 502.03, with these additions and exceptions:

Page 272, subsection 502.03(e). Delete the first paragraph and replace it with this:

Consolidate each layer of concrete, when placed in more than 1 layer, or full depth if placed in 1 lift, by the use of approved vibrators or other approved equipment. Sufficiently and uniformly vibrate the concrete across the full width and depth of the pavement so that the density of pavement concrete is not less than 98 percent of the vibrated unit weight(mass). The 98 percent density requirement may be eliminated on such miscellaneous areas as entrance pavement, median pavement, gore areas, etc. Attain consolidation of these areas by the use of approved vibrators.

Page 284, subsection 502.03(j)(3.1.2). Delete this subsection and replace with this:

(3.1.2) The flexural strength of the pavement shall meet or exceed 450 psi (3.1 MPa). The flexural strength of the pavement shall be determined by testing flexural strength specimens utilizing the third point loading method, or by use of a calibrated maturity meter. If testing is not done, a 4 day curing period shall be observed before motorized traffic is allowed on the pavement.

Page 285, subsection 502.03(k). Delete the entire subsection and replace with this:

(k) Pavement Thickness and Compressive Strength Determination.

(1) General. Determination of pavement thickness and pavement compressive strength for the purpose of establishing pay adjustments will be based on test results from cores taken from each lot of pavement.

- For mainline pavement, pay adjustments will be made for both thickness and compressive strength.
- For acceleration lane, deceleration lane, frontage road, side road and ramp pavement, pay adjustments will be made for thickness, but not compressive strength unless the plans or contract specifically require compressive strength pay adjustments (usually on urban projects).
- For gore areas, bridge approach slabs, intersection curb returns, entrances, shoulders, medians and widenings, pay adjustments will not be made for thickness or compressive strength and pavement cores will not be required.

Where coring is not required, ensure that the thickness of the pavement meets or exceeds the Plan requirements by use of stringline, survey or other suitable depth measurement. For pavement types not cored for strength, use only concrete mix designs approved for use in the mainline pavement. The Engineer will observe and document the Contractor's measurement or

other means of ensuring the appropriate thickness of the plastic concrete and the engineer will verify that only approved mixes are used. Reach agreement with the engineer on any pavement type not specifically defined above as to the applicability of pay factors, prior to placing such pavement.

(2) Lots and Sublots Defined.

(a) For mainline and other pavement subject to coring for pay adjustments for both thickness and strength, a lot is defined as the surface area of mainline lane placed in a single day. Normally, divide a lot representing a day's production into 5 sublots of approximately equal surface area. For high daily production rates, rates exceeding 6000 square yards (sq m) per day, the contractor may choose to divide the day's production into two approximately equal lots consisting of 5 sublots each. Notify the Engineer of the decision to divide a day's production into 2 equal lots prior to taking any core samples. For low daily production rates, the Contractor may choose to divide the lot into a lesser number of sublots as shown below. When daily production rates are less than 500 square yards (sq m), combine the day's production with the next day's production to form a lot. When a day's production involves less than 500 square yards (sq m) while completing a particular mix design or project, combine with the previous day's production and treat as a single lot.

Daily Production Rate in square yards (sq m)	**Number of Sublots**
500 – 2000	3
2001 - 4000	4
4001 or more	5

(b) For pavement that is to be cored for thickness only. Group each continuous section of acceleration lane, deceleration lane, side road, frontage road and ramp pavement of equal plan thickness and bid price into a lot not exceeding 5000 square yards (sq m) in area. Divide each lot into a minimum of three sublots of approximately equal surface area. Sublots shall not exceed 1000 square yards (sq m) in size. Sample each sublot in a manner so that each square yard (sq m) of pavement has a chance of being randomly selected for coring.

(3) Coring.

(a) For mainline and other pavement subject to coring for pay adjustments for both thickness and strength, take 1 core sample having a minimum diameter of 4 inches (100 mm) from a randomly selected site within each sublot. The Contractor has the option of taking an additional core sample having a minimum diameter of 2 inches (50 mm) from a randomly selected site within each sublot for the purpose of making an early determination of the pavement thickness only. Select sites in accordance with the approved quality control plan. The Engineer reserves the right to generate the random locations. If KDOT plans to generate the random locations, the Contractor will be notified before he takes cores to determine thickness. Additionally, take 1 companion core having a minimum diameter of 4 inches (100 mm) per each lot at a randomly selected site as designated by the Engineer. Repair all core holes in a manner approved by the Engineer. All coring for the purpose of determining strength must be performed a

minimum of 21 days after the pavement has been placed, and in time to determine 28-day compressive strengths. Cure cores in moist condition as required in AASHTO T-24 until testing. Coring prior to the 21-day minimum will be permitted, upon approval by the district, when releasing early to traffic.

(b) For all other pavement subject to coring for thickness only, define the lots prior to placement based on Engineer's approval. The Engineer will generate the random locations. If KDOT plans to generate the random locations, the Contractor will be notified before he takes cores to determine thickness.

After placement, randomly select each sublot location. Take 1 core sample having a minimum diameter of 2 inches (50 mm). Repair all core holes in a manner approved by the Engineer. Coring may be performed at any time after all pavement in the lot has been placed.

(4) Mark each core with the lot and sublot number from which it was selected. Transport the cores to the laboratory as soon as possible and perform the thickness determination. Take 3 caliper measurements on each core at approximately 120 degrees apart. Record these 3 measurements to the nearest 0.1 inch (1 mm), and average them to represent the height of that core.

Do not test 2 inch (50 mm) core samples for compressive strength. Do not measure 4 inch (100 mm) cores for pavement thickness determination if a separate 2 inch (50 mm) core sample was taken in a sublot for that purpose.

The measured core height will represent the constructed pavement thickness for each pavement sublot. The Engineer will witness thickness determinations and initial the Contractor's documentation. Then moist cure the 4 inch (100 mm) cores until they are tested for 28-day compressive strength.

Perform the 28-day compressive strength testing on the entire length of the core after squaring the ends according to AASHTO T-24. The compression machine must be capable of testing cores up to and including 12 inches (300 mm) in length. Remove excess length that exceeds compression machine capabilities from the bottom of the cores. Determine length and diameter to the nearest 0.1 inch (1 mm). Divide the length by the diameter to determine the length/diameter ratio (LD), and round the result to the nearest 0.01. After performing the strength test, correct the compressive strength obtained using a correction factor determined by the following formulas:

(a) For LD equal to 2.00, the compressive strength correction factor is 1.000.

(b) For LD less than 2.00, use the following formula and round to the nearest thousandth.

$$\textbf{Compressive Strength Correction Factor} = \frac{100}{95 + 0.2(1/LD) + 19.5(1/LD)^2}$$

(c) For LD greater than 2.00, use the following formula and round to the nearest thousandth.

$$\textbf{Compressive Strength Correction Factor} = \frac{100}{110 - 5(LD)}$$

The compressive strength correction factor may also be obtained by using the following table. If a discrepancy should arise, due to rounding numbers or the appropriate values is not shown in the table, the value determined by the above formulas shall govern.

LD	Compressive Strength Correction Factor	LD	Compressive Strength Correction Factor
1.00	0.872	2.60	1.031
1.10	0.898	2.70	1.036
1.20	0.920	2.80	1.042
1.30	0.937	2.90	1.047
1.40	0.952	3.00	1.053
1.50	0.963	3.10	1.058
1.60	0.973	3.20	1.064
1.70	0.982	3.30	1.070
1.80	0.989	3.40	1.075
1.90	0.995	3.50	1.081
2.00	1.000	3.60	1.087
2.10	1.005	3.70	1.093
2.20	1.010	3.80	1.099
2.30	1.015	3.90	1.105
2.40	1.020	4.00	1.111
2.50	1.026		

Correct the compressive strength determined during testing by multiplying that amount by the compressive strength correction factor.

The Engineer will witness all compressive strength tests for each sublot and initial the Contractors documentation.

Companion cores will be measured and tested at the Department's laboratory. The purpose is to verify the Contractor's test results. For this reason the Contractor must supply 28-day compressive strength data to KDOT. Acceptance of the pavement and pay adjustments will be on the basis of Contractor quality control test results on random samples taken from a lot provided the statistical comparison is favorable.

The Department will routinely compare the variances (F-test) and the means (t-test) of the verifications test results with the quality control test results for thickness and compressive strength as appropriate using a spreadsheet provided by the Department. If the Department's verification test results do not show favorable comparison with the Contractors quality control test results, then the Department's verification test results will be used for material acceptance, material rejection and/or the determination of any pay adjustment for thickness and compressive strength. Follow the requirements stated in **subsection 5.0(6)** of this Special Provision for Failing t-tests. If the contractor disputes the Department's verification test results and the contractor and the engineer cannot mutually agree on the use of the department's test results to determine pay adjustments, then the test results for the lot in question will be voided. In such case, new cores to represent each sublot will be taken on a two-for-one frequency and tested, in the presence of the engineer and a new pay factor will be calculated using the EXCEL spreadsheet. If the new pay factor results in less pay due the contractor than the voided pay

factor, then no payment will be made for the additional coring. Otherwise, the engineer will pay for the additional coring in accordance with **subsection 502.08 (a)** of the **Standard Specifications**.

KDOT will use a spreadsheet program to calculate pay adjustments for thickness and compressive strength, and to compare the Contractor's QC and KDOT's verification test results. KDOT will provide a copy of this program to the Contractor if one is requested. MICROSOFT EXCEL software is required to run this program; it is the Contractor's responsibility to obtain the correct software. Values computed using tables referenced in this Special Provision might vary slightly from the spreadsheet values due to rounding of numbers. In such cases the numbers computed by the spreadsheet shall take precedence.

The comparison of quality control and verification tests will be completed using the t-tests to compare their population means and the F-test to compare their variances. The F and t-tests, along with the EXCEL Spreadsheet used to compare the Contractors Quality Control (QC) results and KDOT's verification (QA) results, are described in Section 5.17.08 of the KDOT Construction Manual. Additional information on the program may be obtained from the Bureau of Materials and Research.

(5) When the measurement of any core is deficient by more than 1 inch (25 mm) from Plan thickness or has a 28-day compressive strength less than 2900 psi (20 MPa), take exploratory cores at not less than 10 foot (3 m) intervals along a line passing through the deficient core and parallel to the centerline of the pavement unit. Continue along this line until an exploratory core is taken in each direction that is not deficient in length by more than 1 inch (25 mm), or is not less than 2900 psi (20 MPa) in compressive strength, depending on which case is being investigated. Exploratory cores will be used only to determine the length of pavement in a unit that is to be left in place without pay or removed and replaced as provided in **subsection 502.08(b)**. If the pavement is left in place or replaced as provided above, discard the original core representing the sublot. Randomly select another core (outside the defective area if left in place) to represent the remainder of the sublot and use to compute the pay factor for the lot.

When the Engineer determines that deficient pavement must be removed, the Contractor is required to remove the deficient areas and replace them with pavement of satisfactory quality, strength and thickness. When it is necessary to remove and replace a length of pavement and one end of the deficient pavement is less than 10 feet (3 m) from an expansion, contraction or construction joint, remove and replace the entire pavement up to the joint, with no additional compensation provided to Contractor. Remove the area so that new joints are a minimum of 10 feet (3 m) apart. No additional compensation for materials or labor involved in the removal or replacement of the deficient concrete pavement will be made.

With the Engineer's consent, the Contractor may choose to leave the deficient pavement in place and receive no compensation or payment for such pavement. The area of concrete pavement for which no payment is made shall be identical with the area of pavement that the Contractor would be required to remove and replace as provided above. Deductions for non-pay deficient thickness or strength pavement will be entered on the final Contractor's Payment Voucher.

(6) For sublot thickness results greater then 1 inch (25 mm) more than design thickness change the sublot thickness result to 1 inch (25 mm) more than the design thickness. The

EXCEL spreadsheet will calculate a new lot mean and sample standard deviation based on the corrected value.

(7) Repair defective pavement slabs according to the provisions of **subsection 502.04**.

(8) Provide rain protection according to the provisions of **subsection 502.05**.

(9) Determine pavement trueness according to the requirements of Special Provision 90M/P-111, latest revision or 90M/P-225, latest revision.

5.0 MEASUREMENT AND PAYMENT.

Page 293, subsection 502.07. Add a new section (g):

(g) The Engineer will measure the quality control testing performed by the Contractor by the square yard (sq m) of PCCP placed on the project.

Page 295, subsection 502.08(a). Delete the last paragraph.

Page 295, subsection 502.08(b). Delete this subsection and replace with this:

(b) Pay Adjustments for Mainline and Other Specified Pavement.

(1) General**.** A single combined pay adjustment for thickness and compressive strength will be made on a lot-by-lot basis and will be based on Contractor quality control test results on all quality control samples representing the lot of the completed pavement provided the statistical check is favorable. Otherwise, see **subsection 502.03(k)(4)** for guidance. The combined pay factor (P) (positive or negative) will be determined and used to compute the pay adjustment by multiplying P times the number of square yards (sq m) included in the lot times the bid price per square yard (sq m). The combined pay factor will be computed as shown in Equation 3. The thickness component of the combined pay factor will be based on the difference between the measured core sample thickness and the lower specification limit (LSL). LSL is defined as 0.2 inch (5 mm) less than plan thickness. The compressive strength component of the combined pay factor will be based on the corrected measured compressive strength of core samples taken from the pavement (see **5.02.03(k)(4)** for LD correction). The pay adjustment amount will be added or subtracted as extras and contingencies on the pay estimate.

Note 1: KDOT will use a spreadsheet program to calculate pay adjustments for thickness and compressive strength and to compare the Contractor's QC and KDOT's verification test results. KDOT will provide a copy of this program to the Contractor if one is requested. It is the Contractor's responsibility to obtain the MICROSOFT EXCEL software required to run this program.

Values computed using equations referenced in this specification may vary slightly from the spreadsheet values due to rounding of numbers. In such cases, the numbers computed by the spreadsheet take precedence.

Note 2: A lot will normally be comprised of the results of five tests performed on a day's placement of a given pavement type. Lot and sublot size is defined in subsection **502.03(k)** of this Special Provision.

Note 3: The sample standard deviation will be computed using the following equation:

$$S = \sqrt{\frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}{n-1}}$$

(2) Thickness Quality Index (Q_T) Computation. Calculate the thickness quality index (Q_T) for the lot using Equation 1 and round to 0.01.

Equation 1: $$Q_T = \frac{\overline{X} - LSL}{S}$$

Where: $\overline{X}$ is the average measured core length of all QC samples representing a lot and is rounded to the nearest 0.1 inch (1 mm.).

LSL is the lower specification limit for thickness and is defined as 0.2 inch (5 mm) less than plan thickness.

S is the sample standard deviation of the measured core lengths of all QC samples representing a lot and is rounded to the nearest 0.01.

(3) Compressive Strength Quality Index (Q_S) Computation. Calculate the compressive strength quality index (Q_S) for the lot using Equation 2 and round to 0.01.

Equation 2: $$Q_S = \frac{\overline{X} - LSL}{S}$$

Where: $\overline{X}$ is the average measured compressive strength of all QC core samples representing a lot and is rounded to 1 psi (0.01 MPa).

LSL is the lower specification limit for compressive strength and is defined as 3900 psi (27.00 MPa).

S is the sample standard deviation of the compressive strength of all QC samples representing a lot and is rounded to 0.01 psi (0.0001 MPa).

(4) Determination of the Percent within Limits Values. First, use the computed Q_T value to determine the thickness percent within limits value (PWL_T) by locating the quality index value in the left column of the Percent Within Limits (PWL) Table in **section 5.17.09** of Part V of the Construction Manual. Select the appropriate percent within limits value (PWL_T) by moving across the selected quality index row to the column representing the number of samples in the lot. Next, follow the same procedure using the computed Q_S value to select the appropriate compressive strength percent within limits value (PWL_S).

If the computed quality index (either Q_T or Q_S) is a negative value ($\overline{X}$ is less than LSL) then the engineer will determine if the material in the lot may remain in place. If the material is left in place (i.e. no cores are found to be more than 1 inch (25 mm) less than plan thickness, or less than 2900 psi (20 MPa) compressive strength, in which case paragraph 502.03(k)(5) would apply), then a value of 50.00 is assigned as the percent within limits value

for thickness or compressive strength (PWL_T or PWL_S), respectively. If the quality index values for both compressive strength and thickness are negative, then assign a value of 50.00 for each percent within limits component.

If the computed quality index value (either Q_T or Q_S) is greater than the largest quality index value shown in the table, then a value of 100.00 is assigned as the percent within limits value for thickness or for compressive strength (PWL_T or PWL_S) respectively, or for both should the quality index values for compressive strength and thickness both exceed the values shown in the table.

(5) Computation of Combined Pay Factor. Compute the combined pay factor for thickness and compressive strength using Equation 3 and round to nearest 0.01.

Equation 3: $$P = \left(\frac{(PWL_T + PWL_S) * 0.60}{200} \right) - 0.54$$

(6) Failing t-test. If the t-test fails, the Department's test result will be used to calculate that particular pay factor for the lot. Follow the procedures given in paragraph (4) above to determine the pay factor or disposition of the lot. Use the following values in Equations 1 and 2 above. The value of $\overline{X}$ will be the Department's test result for the lot, N is equal to the number of Contractor's sublots, the value of S will be 500 psi (3.50 MPa) for strength and ⅜ inch (10 mm) for thickness. The value for the LSL will be as stated above.

Page 295, subsection 502.08. Add the following subsection:

(c) **Pay Adjustments for Pavements Cored for Thickness Only.**

(1) General**.** A single pay adjustment for thickness only will be made on a lot-by-lot basis. It will be based on Contractor quality control test results on all quality control thickness samples representing the lot of the completed pavement provided the statistical check is favorable. Otherwise see **subsection 502.03(k) (4)** for guidance. The thickness pay factor (P_T) (positive or negative) will be determined and used to compute the pay adjustment by multiplying P_T times the number of square yards (sq m) included in the lot times the bid price per square yard (sq m). The thickness pay factor will be computed as shown in Equation 4. The thickness component will be based on the difference between the measured core sample thickness and the *LSL* for thickness. The pay adjustment amount will be added or subtracted as extras and contingencies on the pay estimate.

Note 1: KDOT will use a spreadsheet program to calculate pay adjustments for thickness and to compare the Contractor's QC and KDOT's verification test results. KDOT will provide a copy of this program to the Contractor if one is requested. It is the Contractor's responsibility to obtain the MICROSOFT EXCEL software required to run this program.

Note 2: A lot will normally be comprised of the results of tests performed on all sublots within a given pavement type. Lot and sublot size for pavements cored for thickness only is defined in **subsection 502.03(k)** of this Special Provision.

(2) Determine PWL_T the same as shown in **(b)** above.

(3) Computation of Thickness Pay Factor. Compute the pay factor for thickness using Equation 4 and round to nearest 0.01.

(4) Failing t-test. If the t-test fails, the Department's test result will be used to calculate that particular pay factor for the lot. Follow the procedures given in paragraph (2) above to determine the pay factor or disposition of the lot. Use the following values in Equation 4 below. The value of $\overline{X}$ will be the Department's test result for the lot, N is equal to the number of Contractor's sublots, the value of S will be ⅜ inch (10 mm) The value for the LSL will be as stated above.

Equation 4: $$P_T = \left(\frac{(PWL_T) * 0.30}{100} \right) - 0.27$$

Page 295, subsection 502.08. Add the following subsection:

(d) Payment for the Contractor quality control testing at the Contract unit price is full compensation for the specified work.

In the event of overruns or underruns of the Contractor quality control testing, the Engineer will not adjust the Contract unit price.

10-03-05 M&R (REK)